University of Tripoli - Faculty of Engineering

Electrical & Electronic Engineering Department

EE463 | 1st Exam | Time: 75min | Spring 2017 | 18/4/2017

Q1.a) An alarm light goes ON when a pressure sensor voltage rises above 4.00 V. The pressure sensor outputs 20 mV/kPa and has a time constant of 4.9 s. How long after the pressure rises suddenly from 100 kPa to 400 kPa does the light go ON?

Q1.b) A load cell is calibrated at 21^{c^0} and has the following deflection/load characteristic:

Load(kg)	0	50	100	150	200
Deflection (mm)	0	1	2	3	4

When used at 35^{c^0}, its characteristic changes to the following:

Load(kg)	0	50	100	150	200
Deflection (mm)	0.2	1.3	2.4	3.5	4.6

Determine the sensitivity coefficients [10 pts]

Q2.a) A measurement signal has a frequency less than 1KHz, but there is unwanted noise at about 1MHz. Design a filter that attenuate the noise to 1% using a capacitor 0.01μf. What is the effect on the measurement signal at its maximum of 1KHz (give a comment on the result)?

Q2.b) Signal conditioning analysis shows that the following equation must relate output voltage to input voltage: $V_o=3.35V_{in} - 2.68$. Design circuits to do this using a differential amplifier? [12 pts]

Q3.a) Using timing diagram, explain the control lines that coordinate the operation of ADCs?

Q3.b) Design a 5-bit weighted-resistor DAC whose full-scale output voltage is -15v. Logic levels are 1=5v and 0=0v. What is the output voltage when the input is 01010?

[10 pts]

Good Luck

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spring 2017 1st exam

Q2) a $f_s = 1\,KHz$, $f_N = 1\,MHz$ so use Low pass filter

$$\frac{V_o}{V_{in}} = \frac{1}{\sqrt{1+\left(\frac{f}{f_c}\right)^2}}$$

$$\frac{1}{100} = \frac{1}{\sqrt{1+\left(\frac{1\times10^6}{f_c}\right)^2}} \longrightarrow f_c = 10.0005\,KHz$$

$$\frac{V_o}{V_{in}} = \frac{1}{\sqrt{1+\left(\frac{1k}{10.0005k}\right)^2}} \longrightarrow \frac{V_o}{V_{in}} = 0.9950377$$

$$f_c = \frac{1}{2\pi RC} \longrightarrow R = \frac{1}{2\pi f_c C}$$

$$R = \frac{1}{2\pi \times 10.005\,KHz \times 0.01\,\mu F} \longrightarrow R = 1.59075\,k\Omega$$

use $R = 1.5\,k\Omega$ and recalculate

$f_c = 10.61033\,KHz$

$$\frac{V_o}{V_{in}} = \frac{1}{\sqrt{1+\left(\frac{1k}{10.61033k}\right)^2}} \times 100\% \longrightarrow \frac{V_o}{V_{in}} = 99.5588\%$$

The signal is affected by the filter and it has been atinuated, but since the noise & signal freqencies are so far of each other, the effect is so small

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University of Tripoli – Faculty of Engineering

Electrical & Electronic Engineering Department

EE463 Final Exam Time: 2 hr Spring 2017 3/2/2018

Q1) Temperature sensor sensitivity is 4Ω/ C̊ , in the range (±25°C) and its value at 0°C is 280Ω. Using Wheatstone bridge convert its range to volt , and send its value using (4mA ~20mA transmitter) ,and prepare it for 8bit ADC with voltage reference 0-5Vref. .
a) What is the digital output of ADC at the temperature -2 °C. [12 pts]

Q2) Accelerometer sensor sensitivity is 0.33mA/ g. used for measuring Acceleration in the range (± 20 g). Design signal condition circuits for bipolar (8 bit) ADC with voltage reference ±4V.

a) What is the digital output of ADC at the acceleration is -3 g. 112
b) What is the acceleration when the digital output is 06H. -19 [12 pts]

Q3) Design the signal conditioning circuits to connect the sensor to 10 bit ADC with voltage reference (0~5V), where: sensor output range (-150 ~ +150 mV) with frequency 15Hz, Noise signal 20mV with frequency 150Hz, and design filter that Attenuate the noise signal to 25%, and taking in account the effect of the filter on the sensor signal. [10 pts] $V_o = V_i$ 17.68 ×75

Q4) Using Thermocouple sensor Type J with 0°C reference ,find the value of its output at 32°C. Design circuit to operate cooler if the temperature is more than 32°C, and using RTD with the following table using linear approximation of resistance versus temperature find the value of the RTD at 13°C and design circuit operate heater if the temperature is less than 13°C. [12 pts]

Temperature (°C)	0	5	10	15	20
Resistance (Ω)	107.6	109.1	110.2	111.1	111.7

RTD = 110.8
V_M = 1.436 m

Q5) What is the sampling and sample and hold and aliasing and oversampling (Draw as you can) . [4 pts]

Good Luck (Zeyad)

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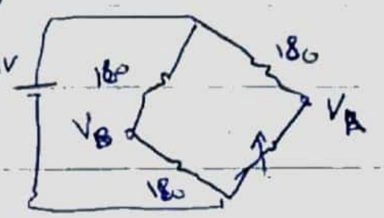
spring 2017 final

Q1) $S = 4\Omega/°C$, $\pm 25°C$ @ $0°C = 280\Omega$, use wheatstone bridge , 4mA~20mA transmitter , 8bit ADC 0~5V

Sensor output range $\left(\left(\frac{4\Omega}{°C} \times -25°C\right) + 280\Omega \sim \left(25°C \times \frac{4\Omega}{°C}\right) + 280\Omega\right)$

$= (180\Omega \sim 380\Omega)$

use R_1 & R_2 & R_4 = 180Ω & $V_s = 9V$



@ $-25°C$ → $V_A = 4.5V$, $V_B = 4.5V$

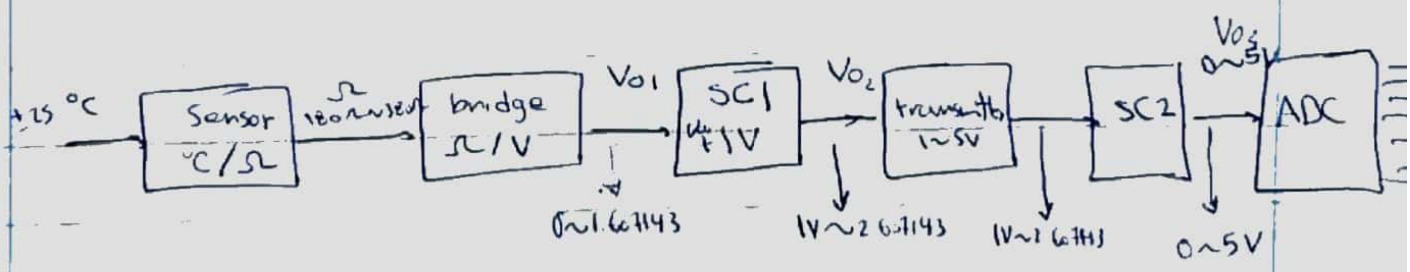
$V_o = V_A - V_B = 0V$

@ $25°C$ → $V_B = 4.5V$, $V_A = 9 \times \frac{380}{380+180} = 6.107143V$

$V_o = V_A - V_B$ = $V_o = 1.607143$

bridge output range (0V ~ 1.607143V)

use transmitter → 1V (1V ~ 2.607143V)



$5 = 2.607143\,M + \text{offset}$

$0 = 1\,M + \text{offset}$

$M = \dfrac{5}{1.607143} \rightarrow M = 3.111111$

$\text{offset} = -3.111111$

$V_{o_3} = 3.111111\,V_{o_2} - 3.111111 \rightarrow$ وبديرو اصول التحقيق لازم

to find digital output @ $-2^{\circ}C$ $\quad R = -2^{\circ} \times 4\,\Omega/^{\circ}C + 280\,\Omega$

$R = 272\,\Omega$, $V_A = 9 \times \dfrac{272}{272+180}$

$V_A = 5.415929\,V \rightarrow \Delta V = V_o = V_A - V_B = V_A - 4.5$

$V_{o_1} = 0.915929\,V \qquad V_{o_2} = V_{o_1} + 1$

$V_{o_2} = 1.915929\,V$, $V_{o_3} = 3.111111\,V_{o_2} - 3.111111$

$V_{o_3} = 2.849557\,V \qquad \text{Digital output} = \dfrac{\text{analog output}}{\Delta V}$

$\Delta V = \dfrac{5-0}{2^8} = 0.01953125$

Digital output $\simeq 145 = \boxed{10010001}$

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Q2 $0.33\,mA/g$, $\pm 20g$, 8bit ADC $\pm 4V$

accelerometer output range $= (0.33\frac{mA}{g} \times -20g \sim 0.33\frac{mA}{g} \times 20g)$

$= (-6.6mA \sim 6.6mA)$

use $R = 1K\Omega$ to convert to volt

$(-6.6mA \times 1K\Omega \sim 6.6mA \times 1K\Omega)$

voltage output range $(-6.6V \sim 6.6V)$

$\cancel{6.6 = 4M + offset}$

$\cancel{-6.6 = -4M + offset}$

$\cancel{M = 1.65 \quad , offset = 0}$

$\cancel{V_{o_2} = 1.65 V_{o_1}}$ → صول الـ ضيق

@ $-3g \rightarrow I = -0.99mA$, $V_{o_1} = -0.99V$

$V_{o_2} = -1.6335V$, $\Delta V = \frac{4-(-4)}{2^8} = 0.03125V$

Digital output $= \frac{-1.6335+4}{0.03125} = 75 \rightarrow \boxed{0100\ 1011}$

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output $(06\ H)_{10} \rightarrow (110)_{2} \rightarrow (6)_{10}$.

$$\text{Digital output} = \frac{\text{analog input} + 4}{0.03125} \quad V_{o_2}$$

$V_{o_2} = (6 \times 0.03125) - 4 = -3.8125V$

$V_{o_1} = \frac{V_{o_2}}{1.65} = -2.310606V$

$I = \frac{V_{o_1}}{1k\Omega} \rightarrow I = -2.310606mA$

~~g~~ acceleration $= \frac{-2.310606mA}{0.33mA/g}$ $\boxed{-7.001836g}$

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Q2. 0.33mA/g , ±20g , 8bit ADC ±4V

accelerometer output range = $(0.33\frac{mA}{g} \times -20g \sim 0.33\frac{mA}{g} \times 20g)$

$= (-6.6mA \sim 6.6mA)$

use R = 1KΩ to convert to volt

$(-6.6mA \times 1K\Omega \sim 6.6mA \times 1K\Omega)$

voltage output range $(-6.6V \sim 6.6V)$

$4 = 6.6M + offset$

$-4 = -6.6M + offset$

$M = 0.606060, offset = 0$

$V_{o_2} = 0.606060 V_{o_1}$ ⟶ دول التضييق

@ $-3g \rightarrow$ $I = -0.99mA$, $V_{o_1} = -0.99V$

$V_{o2} \simeq -0.6$, $\Delta V = \frac{4-(-4)}{2^8} = 0.03125V$

Digital output = $\frac{-0.6 + 4}{0.03125} = 108 \rightarrow \boxed{1101100}$

output $(06\ H)_{10} \rightarrow (110)_2 \rightarrow (6)_{10}$.

$$\text{Digital output} = \frac{\text{analog output } V_{O_2} + 4}{0.03125}$$

$$V_{O_2} = (6 \times 0.03125) - 4 = -3.8125V$$

$$V_{O_1} = \frac{V_{O_2}}{0.60606} = -6.290631V$$

$$I = \frac{V_1}{1k\Omega} \rightarrow I = -6.290631\,mA$$

$$\text{acceleration} = \frac{-6.290631\,mA}{0.33\,\frac{mA}{g}} = \boxed{-19.0625g}$$

Q3 $f_s = 15Hz$, $f_N = 150Hz$ Low pass filter

$$\frac{85}{100} = \frac{1}{\sqrt{1+\left(\frac{150}{f_c}\right)^2}} \rightarrow f_c = 38.729833Hz$$

Use $C = 1\mu F$ find R

$$R = \frac{1}{2\pi f C} \rightarrow R = \frac{1}{2\pi \times 1 \times 10^{-6} \times 38.729833} = 4109.363009\Omega$$

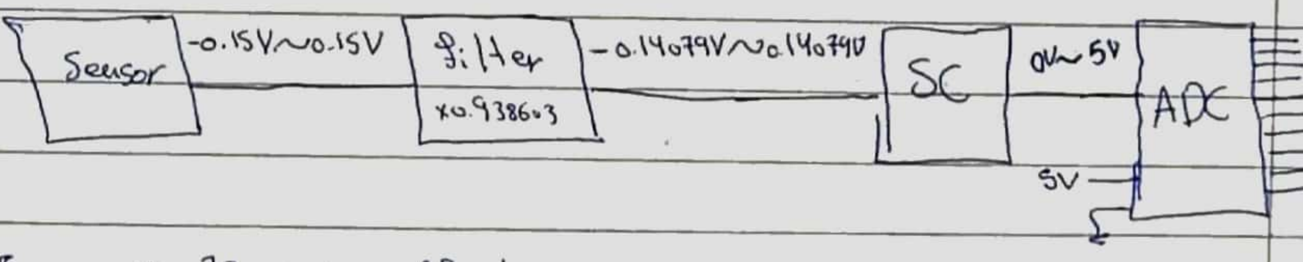
use $R = 3.9k\Omega$

$$f_c = \frac{1}{2\pi \times 1 \times 10^{-6} \times 3900} \rightarrow f_c = 40.80896\,Hz$$

find attinuation ratio for the signal

$$\frac{V_o}{V_{in}} = \frac{1}{\sqrt{1+\left(\frac{15}{40.80896}\right)^2}} \rightarrow \frac{V_o}{V_{in}} = 0.938603$$

filter output range $= (-0.15V \times 0.938603 \sim 0.15V \times 0.938603)$
$= (-0.14079045V \sim 0.14079045V)$



$5 = 0.14079045\,M + offset$
$0 = -0.14079045\,M + offset$
$M = 17.756886$, $offset = 2.5$ $V_o = 17.756886\,V_{in} + 2.5$

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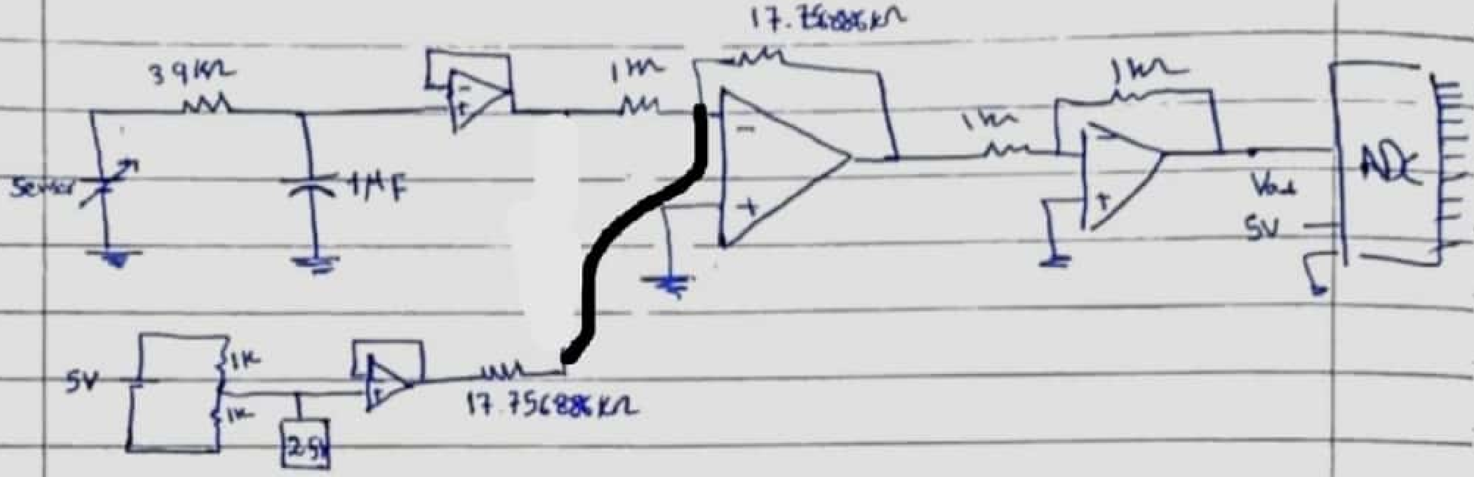
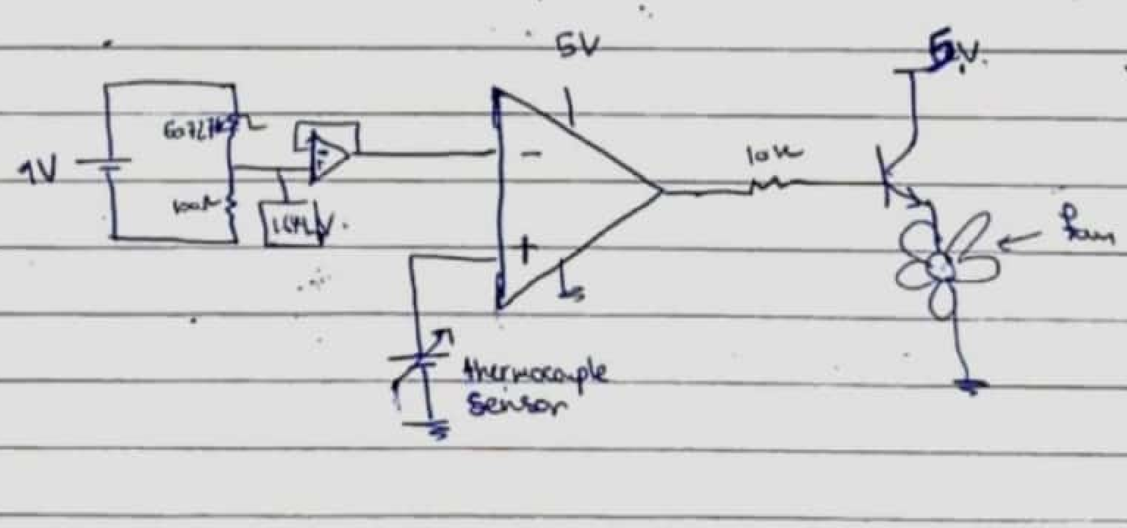
				جدول التحقق
V	-0.14079045	0	0.14079045	
V_o	29×10^{-8} $\simeq 0$	2.5	4.99999997 $\simeq 5V$	



Q4) Thermo couple @ 32°C, Type J, 0°C reference

L	30°	1.54mV	$V_M = V_L + \frac{V_H - V_L}{T_H - T_L}(T_M - T_L)$
M	32°	V_M	
H	35°	1.8mV	$V_M = 1.54 + \frac{1.8 - 1.54}{35 - 30}(32 - 30)$

$V_M = 1.644 \, mV$



$$R(T) = R(T_0)\left(1 + \alpha_0 \overbrace{(T - T_0)}^{\Delta T}\right)$$

$$\alpha_0 = \frac{1}{R(T_0)} \frac{R_2 - R_1}{T_2 - T_1}$$

$T_1 = 0°C \quad R(T_1) = 107.6\,\Omega$

$T_0 = 10°C \quad R(T_0) = 110.2\,\Omega$

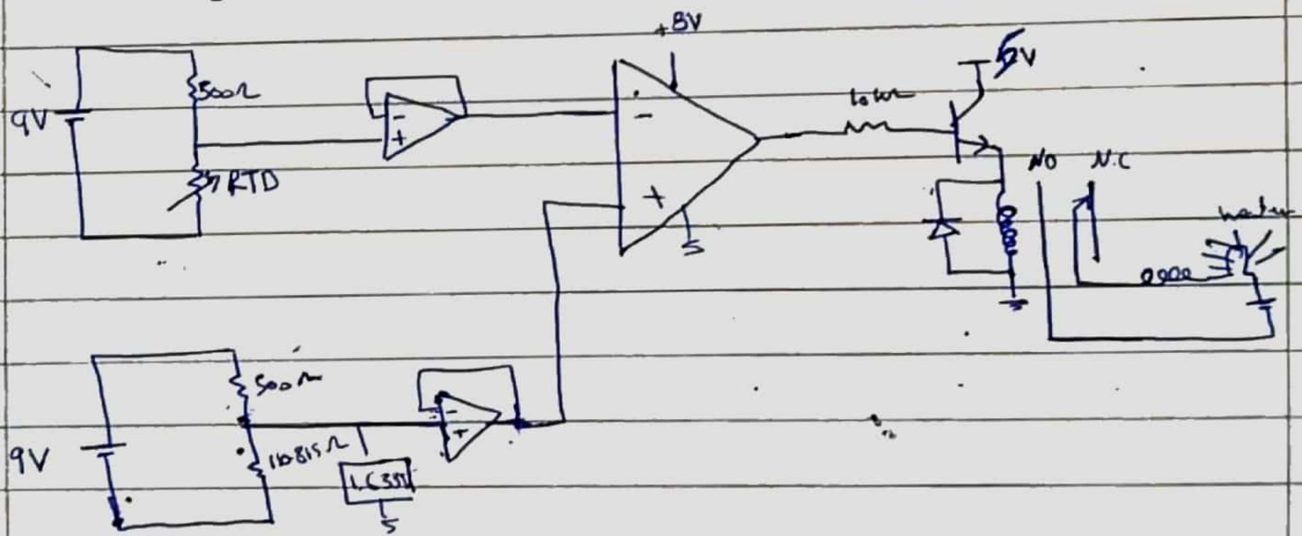
$T_2 = 20°C \quad R(T_2) = 111.7\,\Omega$

$$\alpha_0 = \frac{1}{110.2} \times \frac{111.7 - 107.6}{20 - 0} \rightarrow \alpha_0 = 1.86025 \times 10^{-3}$$

$R(13) = 110.2\,(1 + 1.86025 \times 10^{-3}(13° - 10°))$

$R(13) = 110.8149987\,\Omega$

Use voltage devider, $V_s = 9V$, $R = 500\,\Omega$, $V = 9 \times \frac{110.8149987}{500 + 110.8149987} = 1.6327939V$



University of Tripoli – Faculty of Engineering

Electrical & Electronic Engineering Department

EE463 1st Exam Time: 1: 30 hr Fall 2017 4/11/2017

Q1) What is the basic elements of a data acquisition system, explain two of them?

Q2) What is the deference between single ended signal and differential signal ?

Q3) A length meter range is (0 – 5.5m) has quoted inaccuracy of ±2 % F.S. , what is the maximum measurement error expected for this instrument in centimeter .

Q4) What is Zero drift and sensitivity drift ?

Q5)Calculate the value of the following components:

100k = Green = 5
1000000 = Violet = 7
100 = Red = 2
1000 = orange = 3

Q6)RTD with sensitivity 3Ω/C̊ , and its value= 320Ω @ 0C̊ , use wheatstone bridge to calculate its range in volt for temperature range (0 – 70 C̊) . design s.c. circuit for ADC which voltage reference (0 – 4V) .

-Get the temperature equation

Q7) sensitivity of pressure sensor is (2.8 mA/bar) working in the range (0~15bar) , in a noisy area, design a circuit to transmit its data using (4m ~20mA) transmitter , What is the new range in volt of the sensor .

Good Luck

Better 9
Be 8
Right 7
or 6
your 5
Best 4
guess 3
goes 2
very 1
wrong 0

$A . B \times 10^{C}$

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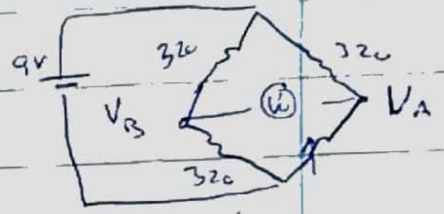
Fall 2017 1st Exam

Q6 $3\Omega/^{\circ}C$ @ $0^{\circ}C = 320\,\Omega$, $(0 \sim 70^{\circ}C)$.

sensor output range $\left((0^{\circ}C \times \frac{3\Omega}{^{\circ}C}) + 320\,\Omega \sim (70^{\circ}C \times \frac{3\Omega}{^{\circ}C}) + 320\,\Omega\right)$

$= 320\,\Omega \sim 530\,\Omega$

use R_1 & R_2 & $R_4 = 320\,\Omega$, $V_s = 9V$



@ $0^{\circ}C \rightarrow V_B = 4.5V$, $V_A = 4.5V$, $V_o = 0V$

@ $70^{\circ}C$ $V_B = 4.5V$, $V_A = 9 \times \frac{530}{530+320} = 5.611765\,V$

$V_o = V_A - V_B = 1.111765V$

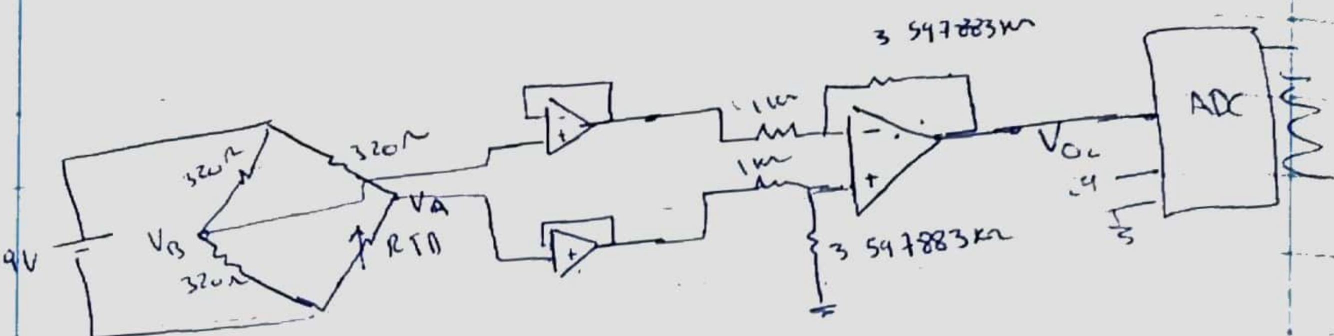
$\boxed{\text{bridge output range } (0V \sim 1.111765V)}$

$4 = 1.111765M + \text{offset}$
$0 = 0M + \text{offset} \rightarrow \text{offset} = 0$

$M = 3.597883$

$V_{o2} = 3.597883 V_{o1}$

V_{o1}	0	0.555883	1.111765
V_{o2}	0	2.000002	4.0000064



assume 8bit ADC $\rightarrow \Delta V = \frac{4}{2^8} = 0.015625V$

~~analog~~ Digital output $= \frac{\text{analog output}}{\Delta V} \rightarrow V_o =$ Digital output $\times \Delta V$

$V_{O_2} = 0.015625$ Digital output

$V_{O_1} = \frac{0.015625}{3.597883}$ Digital output

$V_{O_1} = 0.00434283$ D.O

$V_A = V_{O_1} + V_B \Rightarrow V_A = 0.00434283 V_{D.output} + 4.5$

$V_A = 9 \times \frac{R_{TD}}{R_{TD} + 320\Omega} \rightarrow \frac{V_A}{9} = \frac{R_{TD}}{R_{TD} + 320}$

$R_{TD} = \frac{V_A}{9} R_{TD} + \frac{320 V_A}{9} \rightarrow R_{TD}\left(1 - \frac{V_A}{9}\right) = \frac{320}{9} V_A$

$R_{TD} = \frac{35.555556 V_A}{1 - 0.111111 V_A}$

$$T = \frac{\frac{35.555556 V_A}{1 - 0.111111 V_A} - 320}{3}$$

Q7

sensor range $(0 \sim 15\,bar)$

sensor output range $(0 \times 2.8 \frac{mA}{bar} \sim 15 bar \times 2.8 \frac{mA}{bar})$

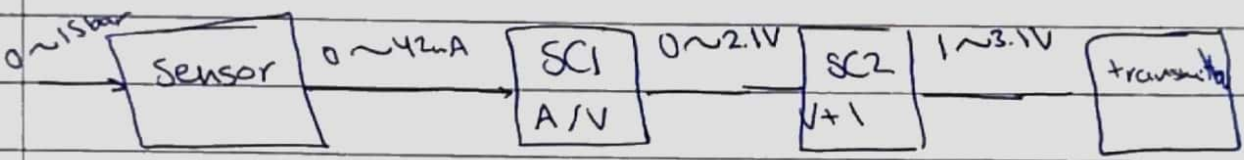
$= (0 \sim 42 mA)$

use $R = 50\Omega$ to current to volt

voltage range = $(0V \sim 2.1V)$

befor transmitter use S.C +1

voltage range = $(1 \sim 3.1V)$



University of Tripoli — Faculty of Engineering

Electrical & Electronic Engineering Department

EE463 2nd Exam Time: 1:30 hr Fall 2017 16/12/2017

Q1) Temperature sensor sensitivity is 0.42mA/ C̊ , used for temperature range (± 50 C̊) Design signal condition circuits for bipolar (8 bit) ADC with voltage reference ±3V.

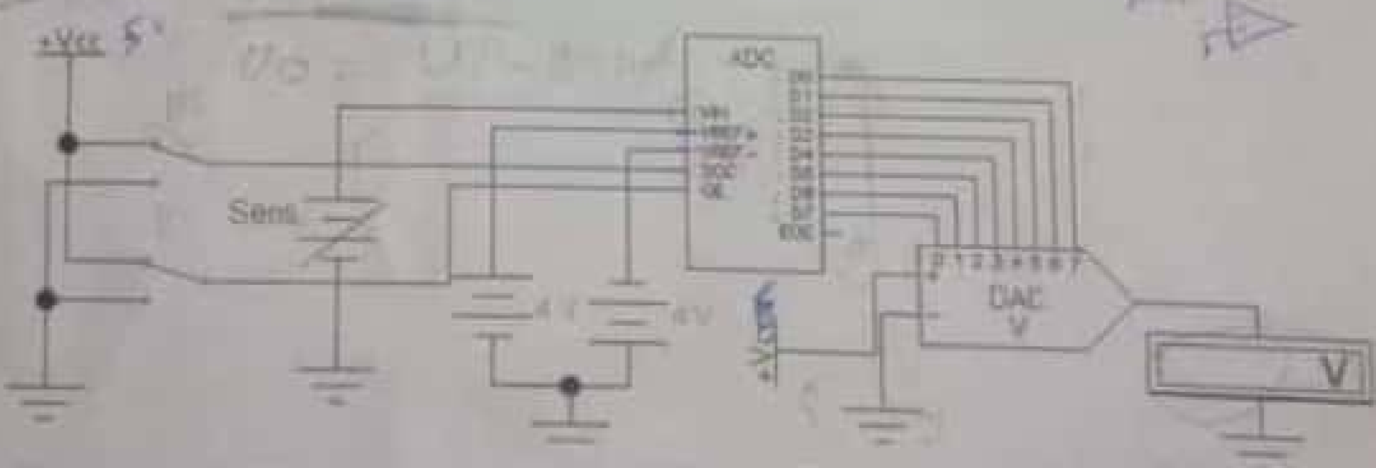
a) What is the digital output of ADC at the temperature 31 C̊, -20 C̊.

b) What is the temperature when the digital output is B6H. [10 pts]

Q2) Design the signal conditioning circuits to connect the sensor to 8 bit ADC with voltage reference (0~10V), where: sensor output range (-100 ~ +100 mV) with frequency 25Hz, Noise signal 20mV with frequency 260Hz, and using filter that Attenuate the noise signal to 29% of its value, and taking in account the effect of the filter on the sensor signal. [10 pts]

Q3) Using pressure sensor which sensitivity is 2.3mV/bar, and temperature sensor which sensitivity is 10Ω/ C̊ and its value at zero C̊ =300Ω. Design circuit which open Valve when the pressure is more than 15bar , and operate heater when temperature is less than 20 C̊, and operate Red LED when both of them are ON. [10 pts]

Q4) What is the digital value of the ADC output and what is the analog value of DAC output at the temperature 23 C̊, and -30 C̊. Where: sensor sensitivity=15mV/ C̊, sensor output at 0 C̊=100mV, sensor range=±50 C̊. [10 pts]



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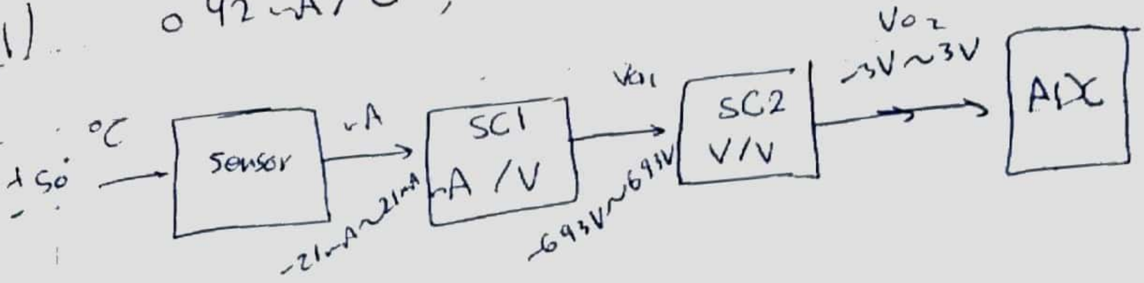
256 128 64 32 16 8 4 2 1

Good Luck (Zeyad)

Fall 2017 2nd Exam

Q1) 0.42 mA/°C , ±50°C , 8 bit ADC ±3V



sensor output range $\left(-50°C \times 0.42\frac{mA}{°C} \sim 50°C \times 0.42\frac{mA}{°C}\right)$

$= (-21mA \sim 21mA)$

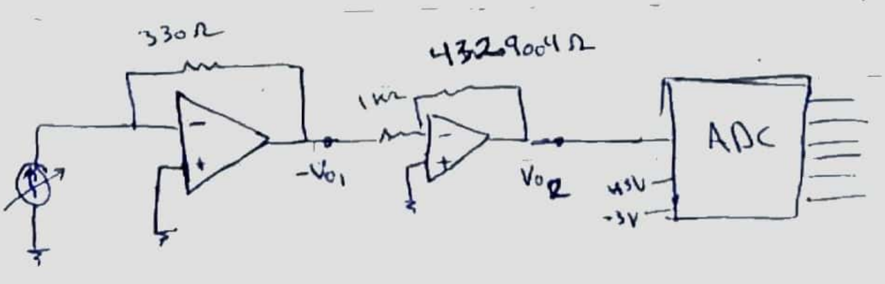
use R = 330Ω → V_{o1} range $(-21mA \times 330\Omega \sim 21mA \times 330\Omega)$
$= (-6.93V \sim 6.93V)$

$3 = 6.93M + \text{offset}$
$-3 = -6.93M + \text{offset}$

$M = 0.4329004$ offset = 0

V_{o1}	−6.93	0	6.93
V_{o2}	−2.9999997	0	2.9999998

$V_{o2} = 0.4329004 V_{o1}$.



@ $31^\circ C$ $\quad I = 13.02\,mA$

$V_{o1} = 4.2966\,V$

$V_{o2} = 1.8599999\,V$

$$\Delta V = \frac{3+3}{2^8} = 0.0234375\,V$$

$$\text{Digital output} = \frac{1.8599999+3}{0.0234375} \approx 207$$

$$= \boxed{11001111}$$

@ $-20^\circ C$ $\approx 76 = \boxed{01001100}$

8 $\quad$ at $(B6)_{16} \rightarrow 182$

$V_{o2} = 1.265625\,V$

$V_{o1} = 2.923594\,V$

$I = 8.859376\,mA$

~~T = 0.0210694°C~~ $T = 21.0937516^\circ C$

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Q2 $f_s = 25Hz$ low pass filter

$f_N = 260\ Hz$

$$\frac{29}{100} = \frac{1}{\sqrt{1+\left(\frac{260}{f}\right)^2}} \rightarrow f_c = 78.785685\ Hz$$

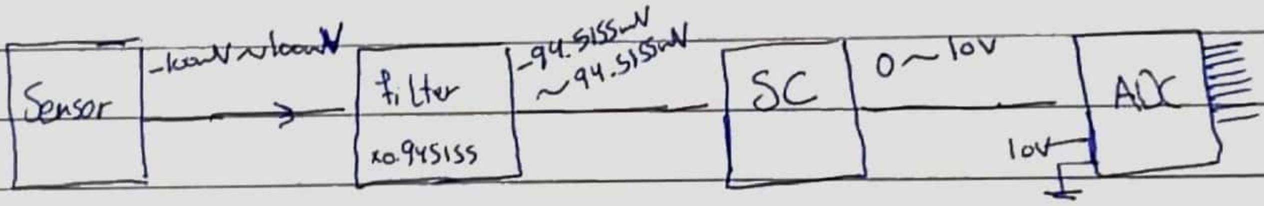
use $C = 1\mu F$ find R

$$R = \frac{1}{2\pi \times 1\times10^{-6} \times 78.785685} \rightarrow R = 2.020099\ k\Omega$$

use $R = 2.2k\Omega$

$$f_c = \frac{1}{2\pi \times 1\times10^{-6} \times 2.2\times10^{3}} \rightarrow f_c = 72.343156\ Hz$$

attenuation ratio $\frac{V_o}{V_{in}} = \frac{1}{\sqrt{1+\left(\frac{25}{72.345156}\right)^2}} = 0.945155$



attenuated signal voltage range $= (-100mV \times 0.945155 \sim 100mV \times 0.945155)$

$= (-0.0945155V \sim 0.0945155V)$

for SC

$10 = 0.0945155M + offset$

$0 = -0.0945155\ M + offset$ $M = 52.901375$, offset $= 5$

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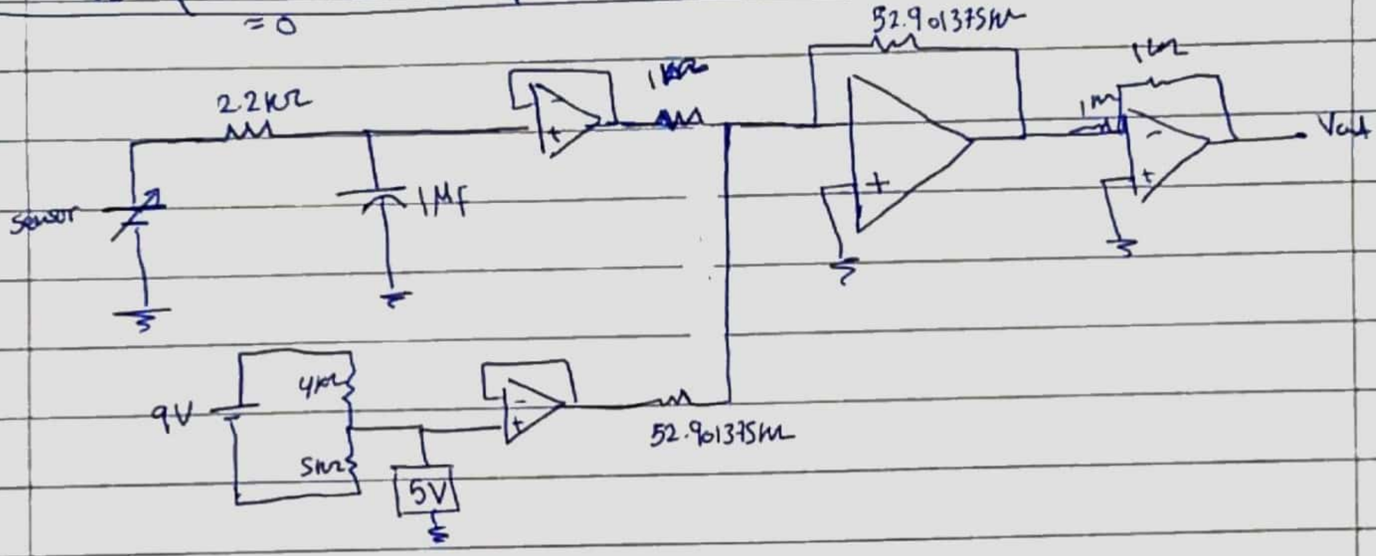
$V_o = 52.901375\, V_{in} + 5$

V_{in}	-0.0945155	0	0.0945155	جدول التحقيق
V_o	9.1×10^{-8} $=0$	5	9.99999991	



Q3) at 15 bar

$$V = 2.3\frac{mV}{bar} \times 15\,bar$$

$$V = 34.5\,mV$$

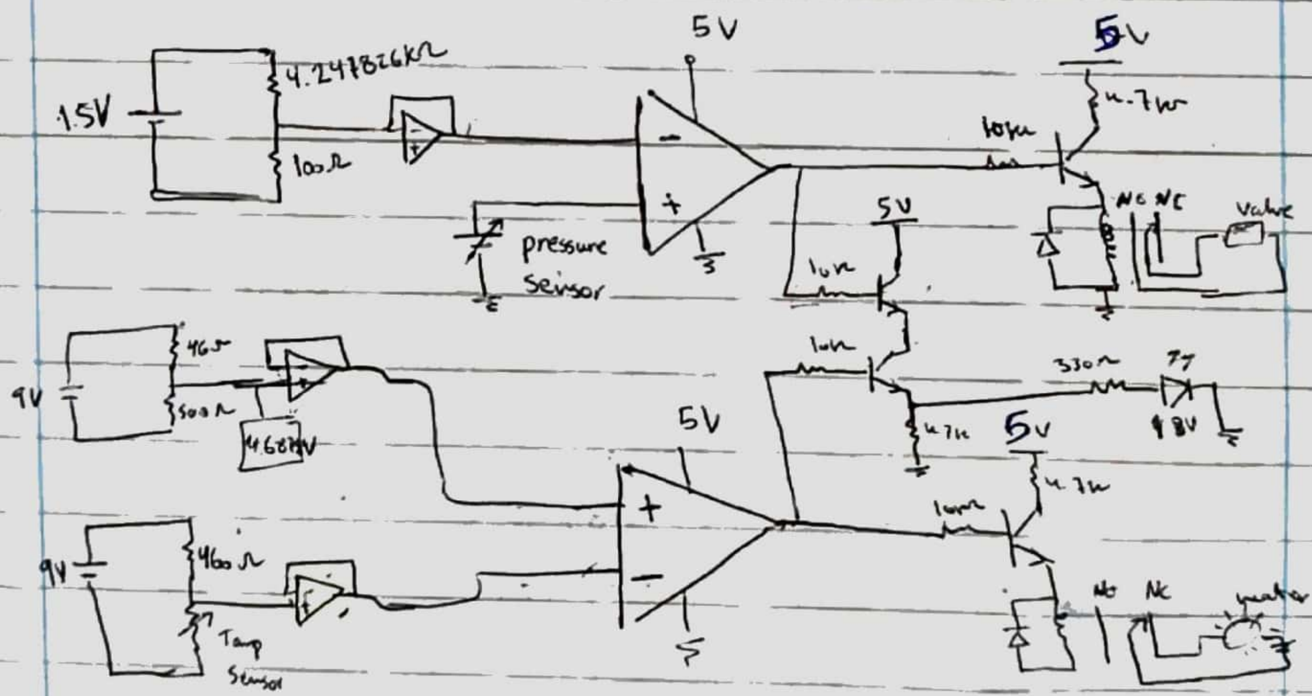
@ 20°C

$$R = \left(10\frac{\Omega}{°C} \times 20°C\right) + 300\,\Omega$$

$$R = 500\,\Omega$$

use Voltage devider $R_1 = 460\,\Omega$ & $V_s = 9V$

$$V_o = \frac{9 \times 500}{500 + 460} \rightarrow V = 4.6875V$$



Q41) at 23°C → $V_o = 23°C \times 15\frac{mV}{°C} + 100mV$

$V_o = 0.445V$

sensor output range $((-50 \times 15) + 100 \sim (50 \times 15) + 100)$

$(-0.65V \sim 0.85V)$

$\Delta V = \frac{4+4}{2^8} = 0.03125V$

Digital output $= \frac{0.445+4}{0.03125} = 142 = \boxed{10001110}$

Digital input for ~~AD~~ DAC = 01110001 = 113

ΔV for DAC $= \frac{5}{2^8} = 0.01953125V$

$V_o = 113 \times 0.01953125 = \boxed{2.20703125V}$

@ -30°C $V_o = -0.35V$

Digital output = 116 → $\boxed{01110100}$

Digital input DAC = 00101110 = 46

$\boxed{V_o = 0.8984375V}$

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University of Tripoli – Faculty of Engineering

Electrical & Electronic Engineering Department

EE463 1st Exam Time: 1:30 hr spring 2018 20/12/2018

Q1)What elements of data acquisition system. explain two of them

Q2) Temperature sensor which sensitivity= 0.11mA/$\mathring{C}$, and its value @ 0$\mathring{C}$=5mA ,for temperature range (±40 $\mathring{C}$), and using R=150 Ω for converting to volt, voltage supply 12V.

A- Design circuit to send the sensor output for long distance and for ADC (Vref 0~4V).

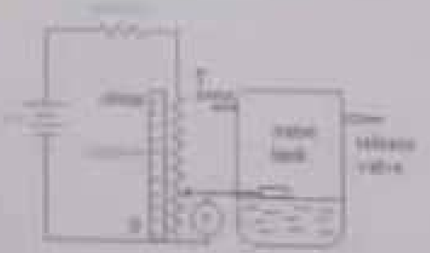
B- What is the digital output of ADC if the temperature is 33C, -14C ?

C- What is the temperature if the digital output is 88H?

Q3) Sensor used to measure pressure in range (0~30bar) with sensitivity (7mV/bar) , RTD PT100 to measure temperature, potentiometer used to measure the level as shown in figure.

A-Design circuit to turn ON buzzer if (temp is more than 49C or pressure is more 10 bar or level is less than 33cm)

B-Turn ON release valve if pressure is more than 15 bar.



Good Luck (Zeyad Hamza)

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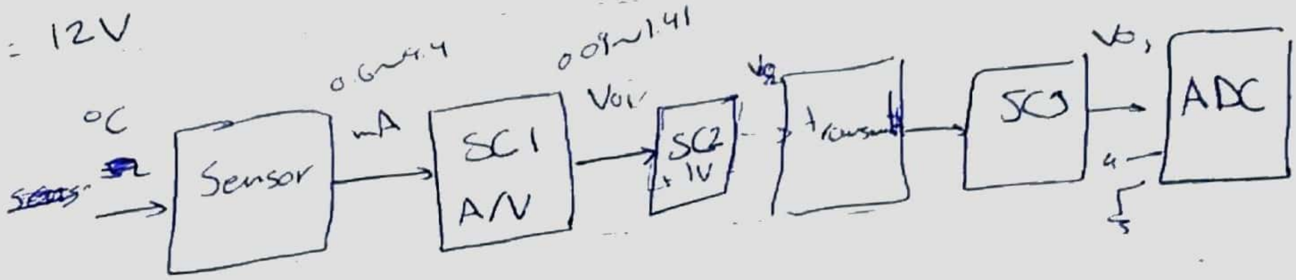
Spring 2018 1st

Q2 $S = 0.11\,mA/°C$ @ $0°C = 5mA$ $\pm 40°C$ $R = 150\Omega$

$V_s = 12V$

a)



sensor output range (0.6mA ~ 9.4mA)

$R = 150\Omega$

SC1 output range (voltage) = (0.09V ~ 1.41V)

SC2 → $V_{o2} = 1 + V_{o1}$

SC2 output range (1.09V ~ 2.41V)

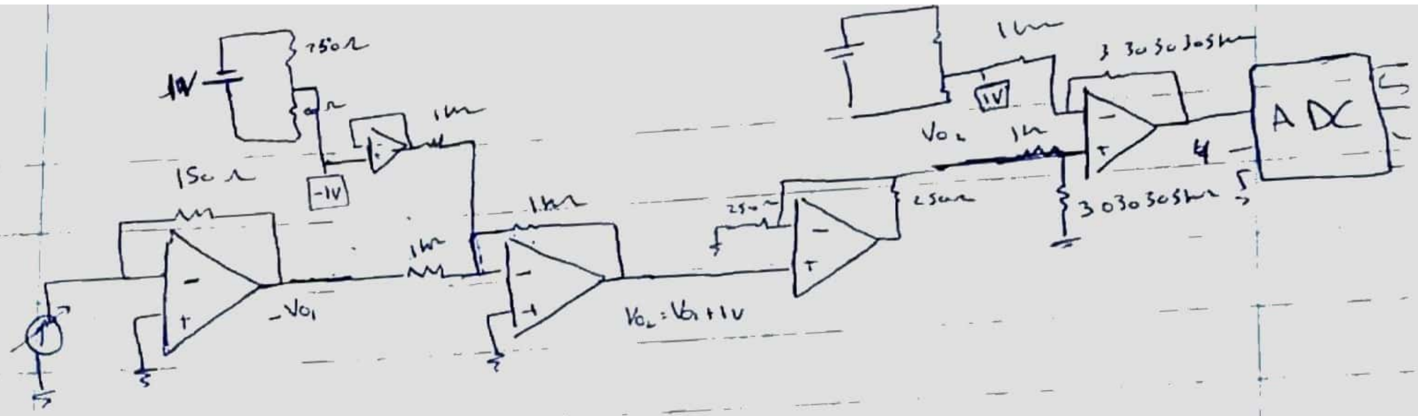
SC3 $4 = 2.41M + \text{offset}$

$0 = 1.09M + \text{offset}$

$M = 3.030303$ offset = -3.303030

$V_{o3} = 3.030303\,V_{o2} - 3.3030303$

V_{o2}	1.09	1.75	2.41
V_3	0	2	4



B @ 33°C → V_{O_3} = ~~ ~~ 3.65V

$\Delta V = \frac{4}{2^8} = 0.015625$

Digital output = 233 → 11101001

@ -14 → V_{O_3} = 1.3V

Digital output = 83 → 01010011

C 88H → $(136)_{10}$

V_{O_3} = 2.125V → 25°T

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Q3) → for tank use $V_s = 12V$, $R_1 = 400\Omega$, $R_{pot} = 52k\Omega$, $h_{tank} = 50cm$

1) for pressure sensor @ 10 bar

$$V = 10\,bar \times \frac{7mV}{bar} = \boxed{70mV}$$

2) for RTD PT100 @ 49°C

$$R = 49° \times 0.39\frac{\Omega}{°C} + 100\Omega \rightarrow R = 119.11\,\Omega$$

use voltage devider $V_s = 9V$, $R_1 = 500\Omega$

$$V = 9 \times \frac{119.11}{119.11+500} \rightarrow \boxed{V = 1.731502V}$$

3) for the tank

$$0cm \longrightarrow 0V$$

$$50cm \longrightarrow 12 \times \frac{52}{52+0.4} = 11.14285714V$$

so $S = \frac{11.14285714V}{50\,cm} = 0.222857V/cm$

@ 33 cm → $V = 0.222857 \times 33 = \boxed{7.354281V}$

for B: @ 15 bar

$$V = 15\,bar \times \frac{7mV}{bar} = \boxed{105mV}$$

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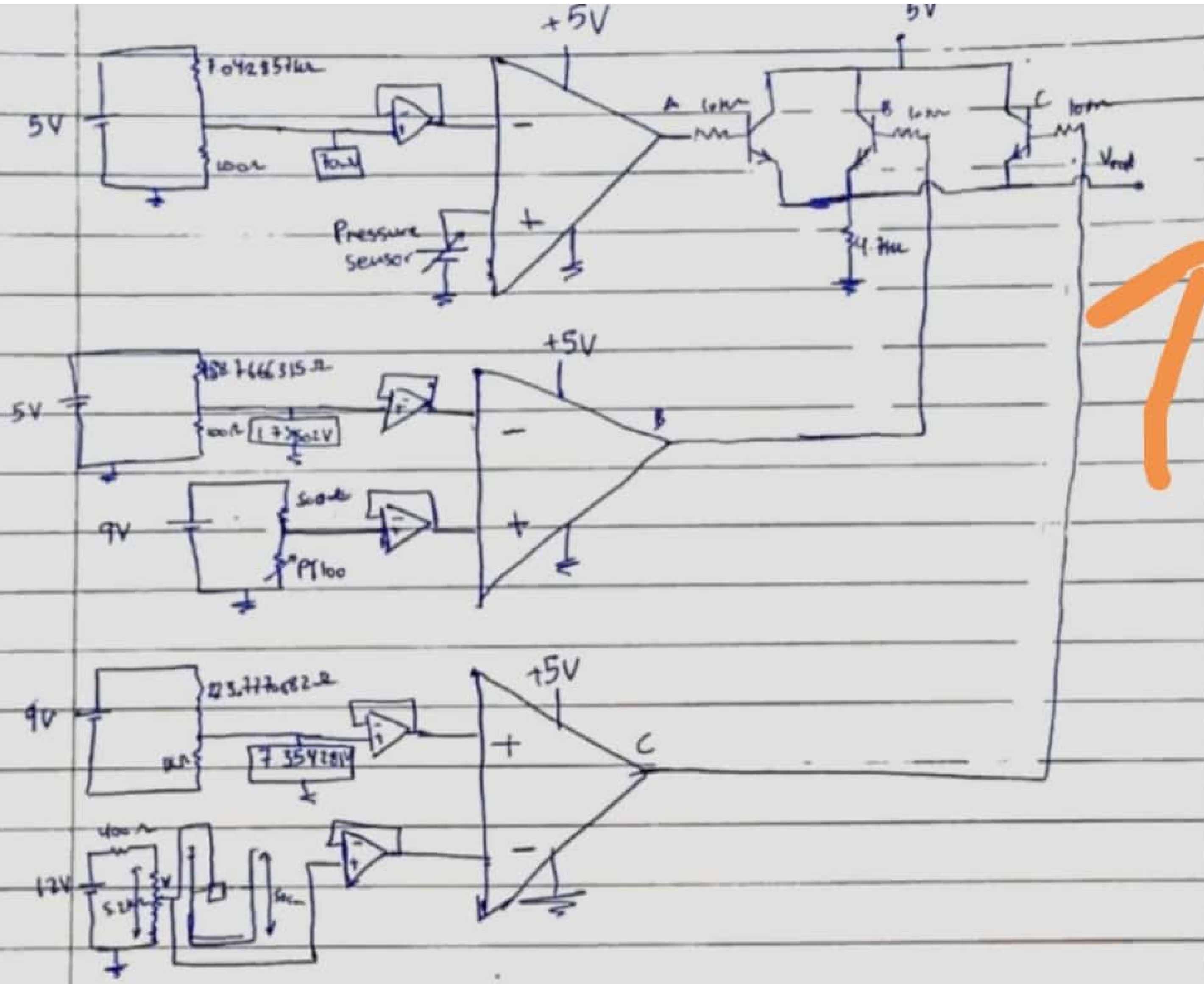
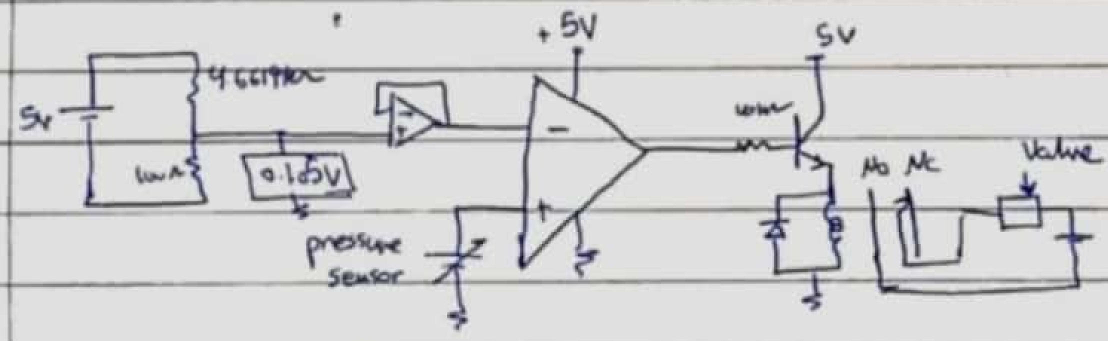


B



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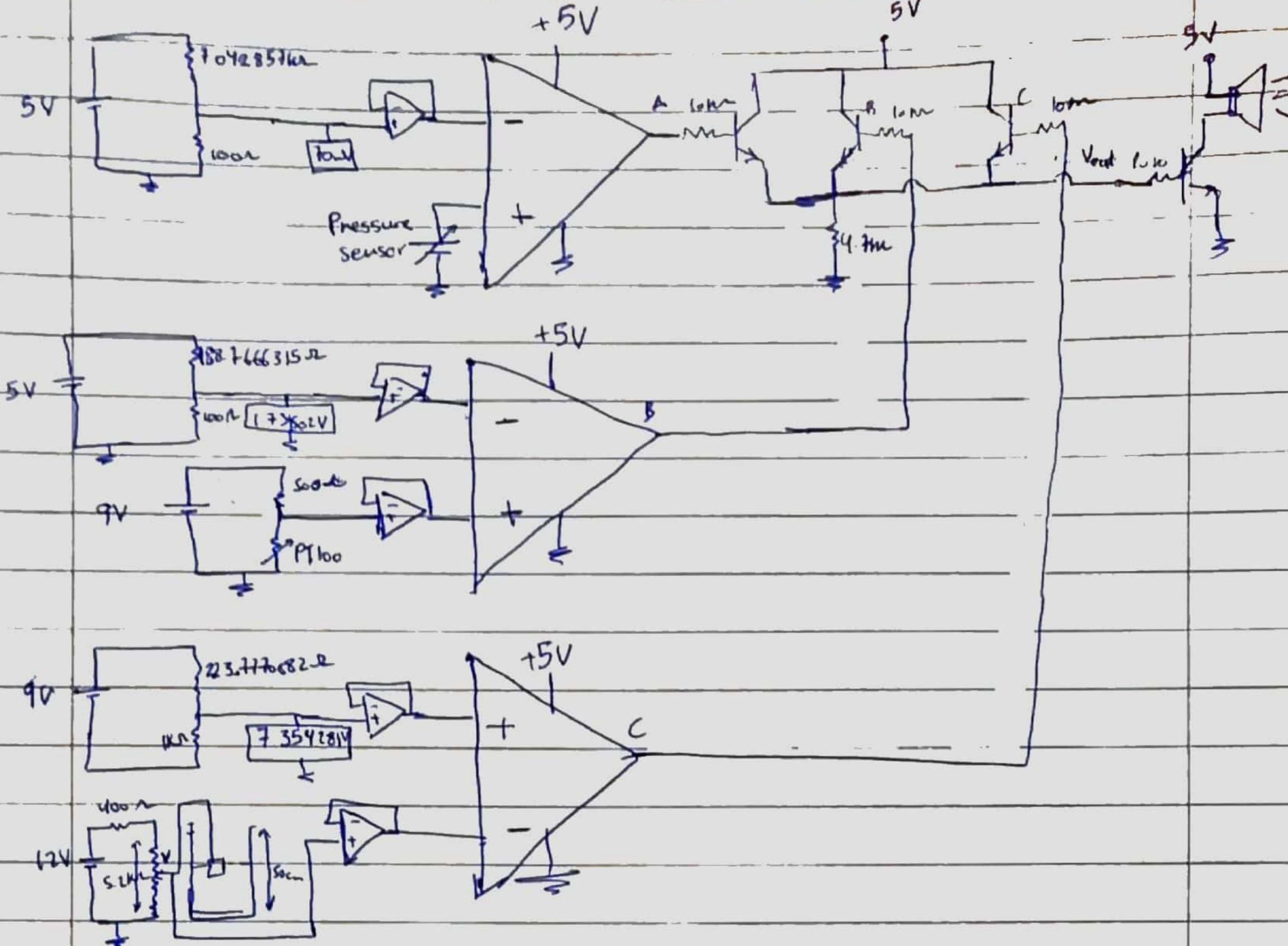
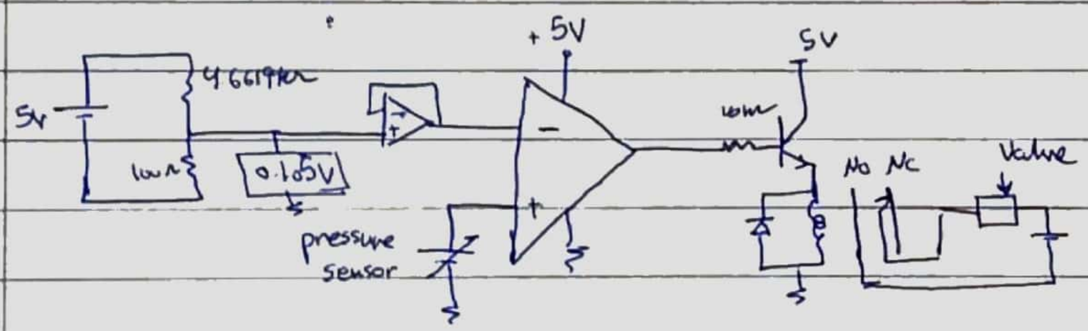


B



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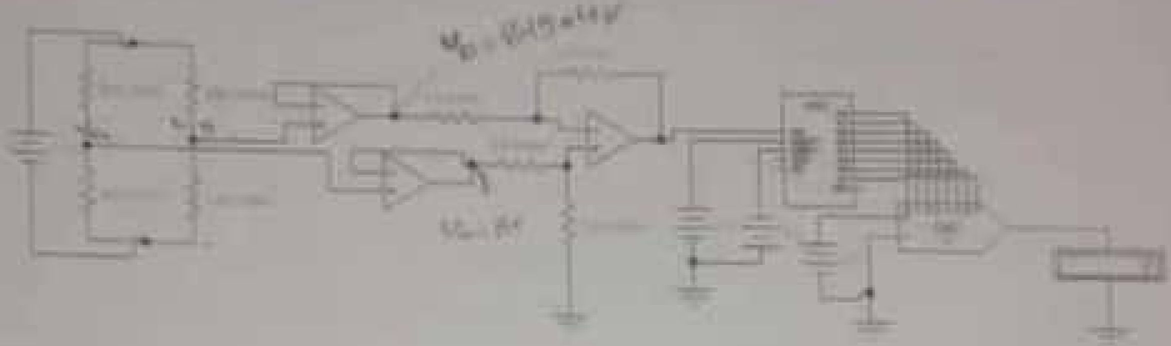
Electrical & Electronic Engineering Department

EE463 2nd Exam Time: 1:30 hr spring 2018 1/1/2019

Q1) From the circuit below what is the value of ADC digital outputs and DAC analog output.



Q2) A measurement signal has a frequency 800Hz,but there is unwanted noise at about 10KHz .Design filter that attenuate noise as possible with better effect on the signal(give the 3 attempts with comments).

Q3) using accelerometer which sensitivity 0.3mA/g , and using R=200Ω for voltage conversion, and using VFC which scale factor 5KHz/V, sampling time 0.1sec :

A) Draw the block diagram of the operation
B) What is the digital output(in binary) if the acceleration is 11g.
C) What is the value of acceleration if the digital output is $(190)_{10}$

Good Luck (Zeyad Hamza)

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spring 2018 2nd exam

Q2 $f_s = 800Hz$, $f_N = 10 KHz$ low pass filter

1) 1%

$$\frac{1}{100} = \frac{1}{\sqrt{1+\left(\frac{10k}{f_c}\right)^2}} \longrightarrow f_c = 100.005 Hz \text{ (less than } f_s)$$

for the signal

$$\frac{V_o}{V_{in}} = \frac{1}{\sqrt{1+\left(\frac{800}{100.005}\right)^2}} \times 100\% = 12.4\% \text{ very poor}$$

2) 10%

$$\frac{10}{100} = \frac{1}{\sqrt{1+\left(\frac{10k}{f_c}\right)^2}} \longrightarrow f_c = 1005.037815Hz$$

$$\frac{V_o}{V_{in}} = \frac{1}{\sqrt{1+\left(\frac{800}{1005.037815}\right)^2}} \times 100\% = 78.239693\% \text{ accepted}$$

3) 15%

$$\frac{15}{100} = \frac{1}{\sqrt{1+\left(\frac{10k}{f_c}\right)^2}} \longrightarrow f_c = 1517.165212 Hz$$

$$\frac{V_o}{V_{in}} = \frac{1}{\sqrt{1+\left(\frac{800}{1517.165212}\right)^2}} \times 100\% \longrightarrow = 88.4559\% \text{ better for the signal}$$

but less attenuation of noise

use 15%, take $C = 0.1\mu F$

$$R = \frac{1}{2\pi \times 1517.165212 \times 1\times 10^{-6}} \longrightarrow R = 1049.028 \quad \text{use } R = 1k\Omega,\ C = 0.1\mu F$$

$f_c = 1591.549431 Hz$

$\frac{V_o}{V_{in}}\% = 89.347637\%$

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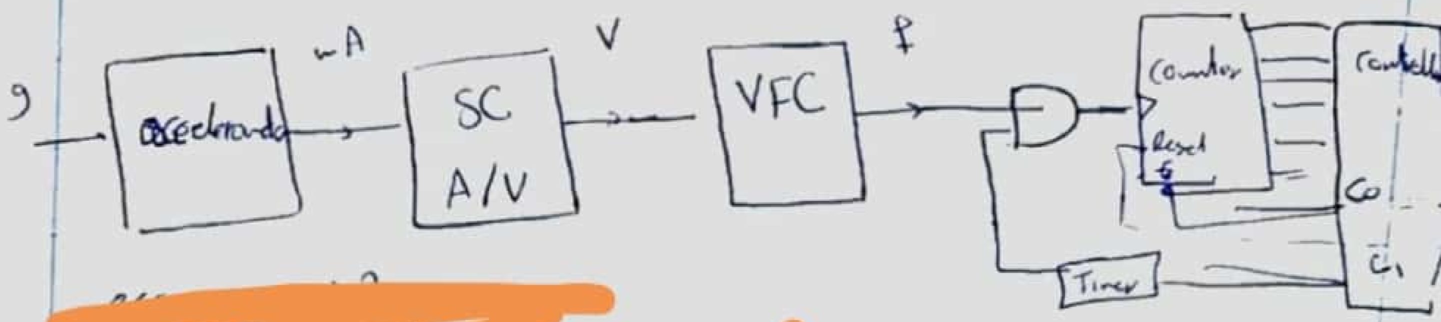
Spring 2018 2nd

Q3 $S = 0.3\,mA/g$ $R : 200\,\Omega$ VFC $5\,KHz/V$, $T = 0.1\,sec$



[redacted]

B @ 11g → 10100101

C if 190 → g = 6.33.

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Sample/Sec

Hz   Sampl

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Electrical & Electronic Engineering Department

EE463   Final Exam   Time: 2 hr   Spring 2018   17/7/2018

V/KHz   1/KHz

Sample/Sec

Q1) a- What is the meaning of single ended signal and differential signal. Hz

b- Why sometimes we are holding the sampling signal. [4 pts]

Q2) Using Temperature sensor (sensitivity =5mV/C), in the range (30C to 120C) and using voltage to frequency converter VFC (scale factor= 2V/1KHz). 2V/1KHz

Calculate the sensor output range, and VFC output range.

Using a counter to convert to digital with sampling rate 10sample/Sec, what is the value of the output of the counter if the temperature is 112C. 75 Hz [8 pts]

Q3) Barometer sensor sensitivity is 0.13mA/ bar, used for measuring pressure in the range (± 20 bar). and the value of its output @ 0 bar is 4mA, using 150 Ω, Design signal condition circuits for bipolar (8 bit) ADC with voltage reference ±4V.

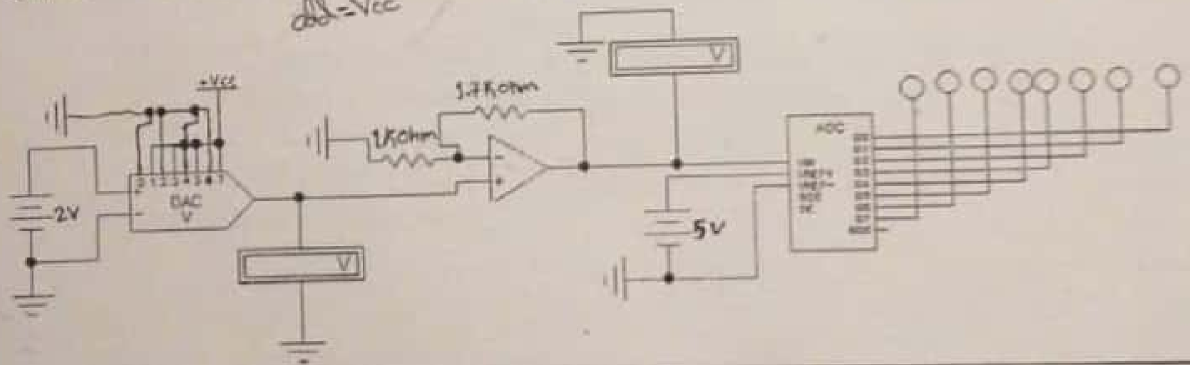
V/V/KHz

a) What is the digital output of ADC at the ~~acceleration~~ pressure is 8 bar.

b) What is the value of pressure when the digital output is 18H. [16 pts]

Q4) What is the value of voltmeters and ADC output. [12 pts]

-Vcc



Q5) a- Using Thermocouple sensor Type J with 40C reference, What is the value of its output at the temperature 120C.

b- Using RTD with the following table using Quadratic approximation of resistance versus temperature find the value of the RTD at 11.4°C.

Temperature (°C)	0	5	10	15	20
Resistance (Ω)	107.6	109.1	110.2	111.1	111.7

[10 pts]

Good Luck (Zeyad)

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spring 2018 . final

Q2) $S = 5mV/°C$, $30°C \sim 120°C$ VFC $2V/KHz$

sensor output range $(0.15V \sim 0.6V)$

VFC sensitivity 2V → 1 KHz

S : 500 Hz /V 1V → ?

VFC output range (75 Hz ~ 300 Hz)

@ 112°C $V_o = 0.56V$, $f_o = 280 Hz$

Sampling time = 0.1 sec

counter input = 28

$\boxed{\text{Counter output} = 11100}$

Q3) $S = 0.13 mA/bar$ ± 20 bar @ 0 bar = 4mA , $R = 150\Omega$

±4V ADC 8 bit

sensor output range = (1.4 mA ~ 6.6 mA)

SCI output range = (0.21V ~ 0.99V)

4 = 0.99 M + offset $V_{o2} = 10.25641 V_{o1} - 6.153846$

-4 = 0.21 M + offset

M = 10.25641 , offset = -6.153846

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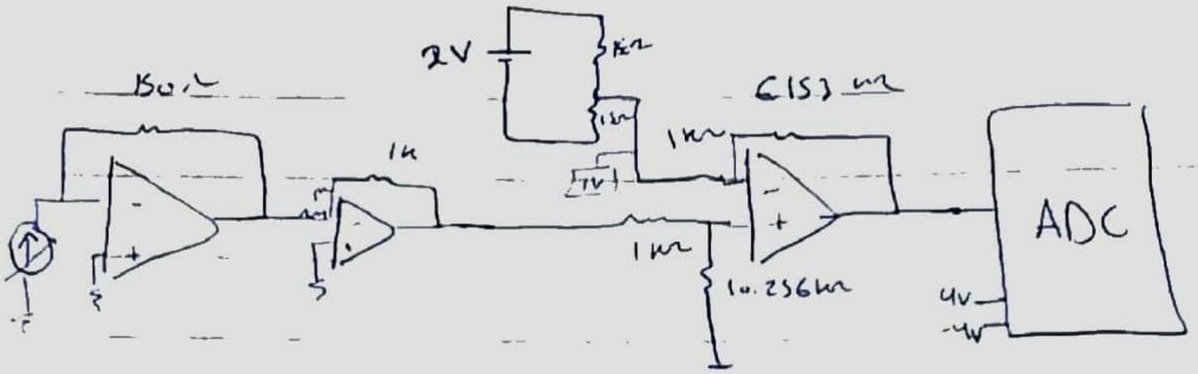

ⓐ 8 bar → 1.6V

$\Delta V = \frac{8}{2^8} = 0.03125$ $\qquad \frac{1.6+4}{0.03125} = 179$

→ ≃ 179 = 1011 0111

18H → $(24)_{10}$

$V_{o_2} = -3.25V$

V_{o_1} = → −16.25 bar

Q4 ΔV DAC $= \frac{2}{2^8} = 0.0078125V$

Digital input = 10101010 = 170

$V_1 = 1.328125V$

$V_2 = \left(1 + \frac{R_4}{R_1}\right) V_1 = 3.5859375V$

ADC $\Delta V = 0.01953125V$

Digital output = 183 → 10110111

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Q5a) $V_{J40}(120^\circ C) = V_{J0}(120^\circ C) - V_{J0}(40^\circ C)$

$= 6.36\ mV - 2.06\ mV$

$$\boxed{V_{J40}(120^\circ C) = 4.3\ mV}$$

b) $R(T) = R(T_0)\left(1 + \alpha_1 \Delta T + \alpha_2 (\Delta T)^2\right)$

$T_1 = 0^\circ C$, $T_0 = 10^\circ C$, $T_2 = 20^\circ C$

$R(T_1) = 107.6\,\Omega$, $R(T_0) = 110.2\,\Omega$, $R(T_2) = 111.7\,\Omega$

$R(0) = R(10)\left(1 + \alpha_1(0-10) + \alpha_2(0-10)^2\right)$

$107.6 = 110.2\left(1 - 10\alpha_1 + 100\alpha_2\right)$

$0.9764065 - 1 + 10\alpha_1 - 100\alpha_2 = 0 \rightarrow \boxed{10\alpha_1 - 100\alpha_2 - 0.0235935 = 0} \rightarrow 1$

$R(20) = R(10)\left(1 + \alpha_1(20-10) + \alpha_2(20-10)^2\right)$

$111.7 = 110.2\left(1 + 10\alpha_1 + 100\alpha_2\right)$

$10\alpha_1 + 100\alpha_2 + 1 - 1.013612 = 0$

$\boxed{10\alpha_1 + 100\alpha_2 - 0.013612 = 0} \rightarrow 2$

$\alpha_1 = 1.860275 \times 10^{-3}$, $\alpha_2 = -4.99075 \times 10^{-5}$

$R(11.4) = R(10)\left(1 + \alpha_1(11.4-10) + \alpha_2(11.4-10)^2\right)$

$R(11.4) = 110.2\left(1 + (1.860275 \times 10^{-3} \times 1.4) + (-4.99075 \times 10^{-5} \times 1.96)\right)$

$$\boxed{R(11.4^\circ C) = 110.476223\,\Omega}$$

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Electrical & Electronic Engineering Department

EE463 | Final Exam | Time: 2 hr | Fall 2018 | 12/2/2019

Q1) a-Using RTD PT100 for temperature range (22C to 190C),design a signal conditioning circuit for (0–3V) ADC.(use voltage divider circuit ,Vs=9V,R1=200Ω).

b-If we will send the sensor output for a distance with same voltage reference.

c-What is the ADC digital output if the temperature is 100C.

d-What is the temperature if the ADC output is (10011110). ref = 2V [14 pts]

Q2) Using Acceleration sensor (sensitivity =0.14mA/g),with offset 7mA@0g, for the range (±30g) and using voltage to frequency converter VFC (scale factor= 4V/6KHz) .

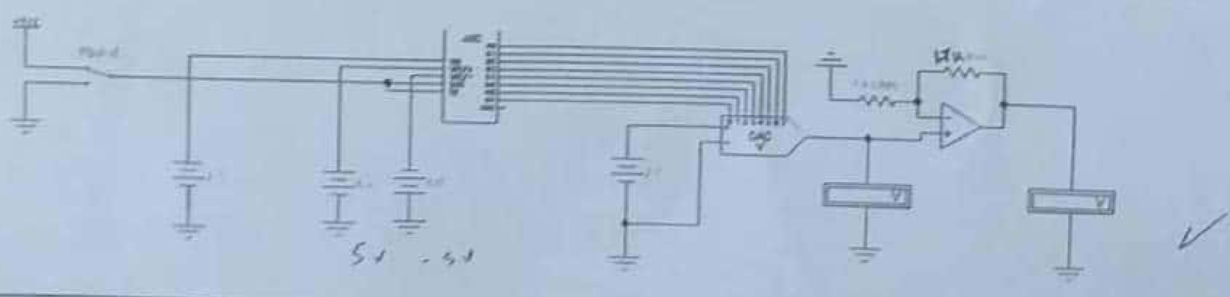
a-Draw the block diagram of the operation.

b-Calculate the sensor output range, and VFC output range, digital output of counter if the sampling is each 0.2Sec.

c-What is the value of the output of the counter if the acceleration is -0.5g. [10 pts]

Q3) Barometer sensor sensitivity is 5mV/ bar , and 5Ω/cm pot. level sensor for 150cm range used for measuring level (Vs=9Vuse, R1= 150 Ω) ,Design) circuit to turn ON green LED if (level more than 70cm and pressure less than 5bar),red LED if one of them opposite these values. [10 pts]

Q4) What is the value of voltmeters and ADC and DAC outputs. [8 pts]



Q5) a- Using Thermocouple sensor Type K with 0C reference, What is the value of temperature if its output is 19mV, What is its output at the temperature $V_{K10}(-40C)$=?. [8pts]

Good Luck (Zeyad)

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Fall 2018 Final

Q1) PT100 (22°C ~ 190°C) ADC 0~3V

$V_S = 9V$, $R_1 = 200\Omega$

sensor output range = (108.58Ω ~ 174.1Ω)

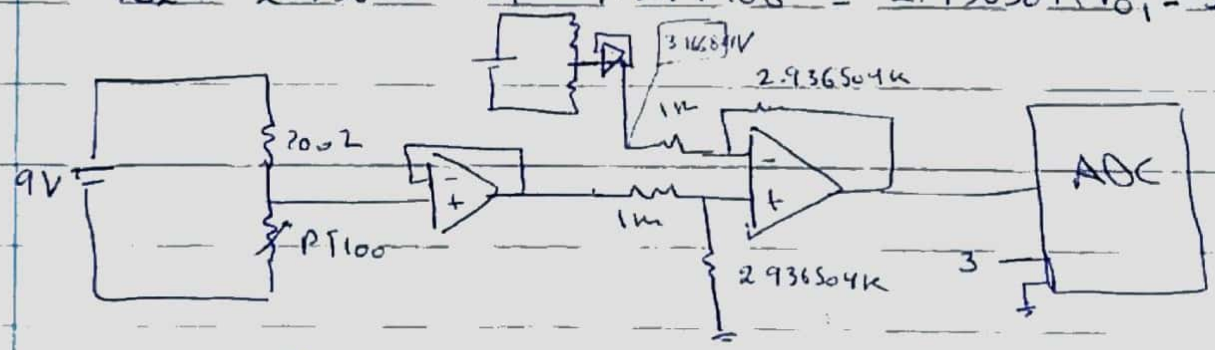
VD output range = (3.166829V ~ 4.188452V)

3 = 4.188452 M + offset

0 = 3.166829 M + offset

M = 2.936504 , offset = −9.299406

$V_{O2} = 2.936504\, V_{O1} - 9.299406 = 2.936504(V_{O1} - 3.166829)$



$\Delta V = \frac{3}{2^8} = 0.01171875V$

@ 100°C V_{O2} : 1.537073 → Digital output = 131 = 1000 0011

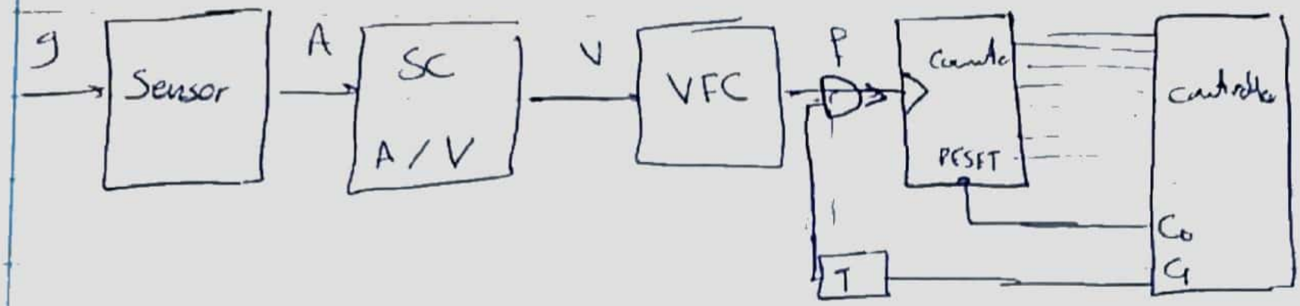
@ 10011110 → ~~78~~ 158 → V_{O2} = ~~0~~ ~~[illegible]~~ 1.8515625

~~V_{O1} =~~ R ~~115~~ 975 T = 117.8931°C

→ T ~~66.6026°C~~

Q2) $S = 0.14mA/g$ @ $0g = 7mA$ $\pm 30g$ VFC

4V/6KHz



Sensor output range = (2.8mA ~ 11.2mA)

use R = 500Ω

Voltage output range = (1.4V ~ 5.6V)

VFC → 4V → 6KHz

1V → x $\frac{6KHz \times 1V}{4V}$ =

VFC → 1.5 KHz/V

VFC output range (2.1KHz ~ 8.4KHz)

counter output (420 ~ 1680)

c. @ -0.5g → 1039.5 ≈ 1039

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Q3). $\rho' = 5mV/bar$, $5\Omega/cm$ pot $150cm$, $V_S = 9V$, $R_1 = 150\Omega$

at 70 cm

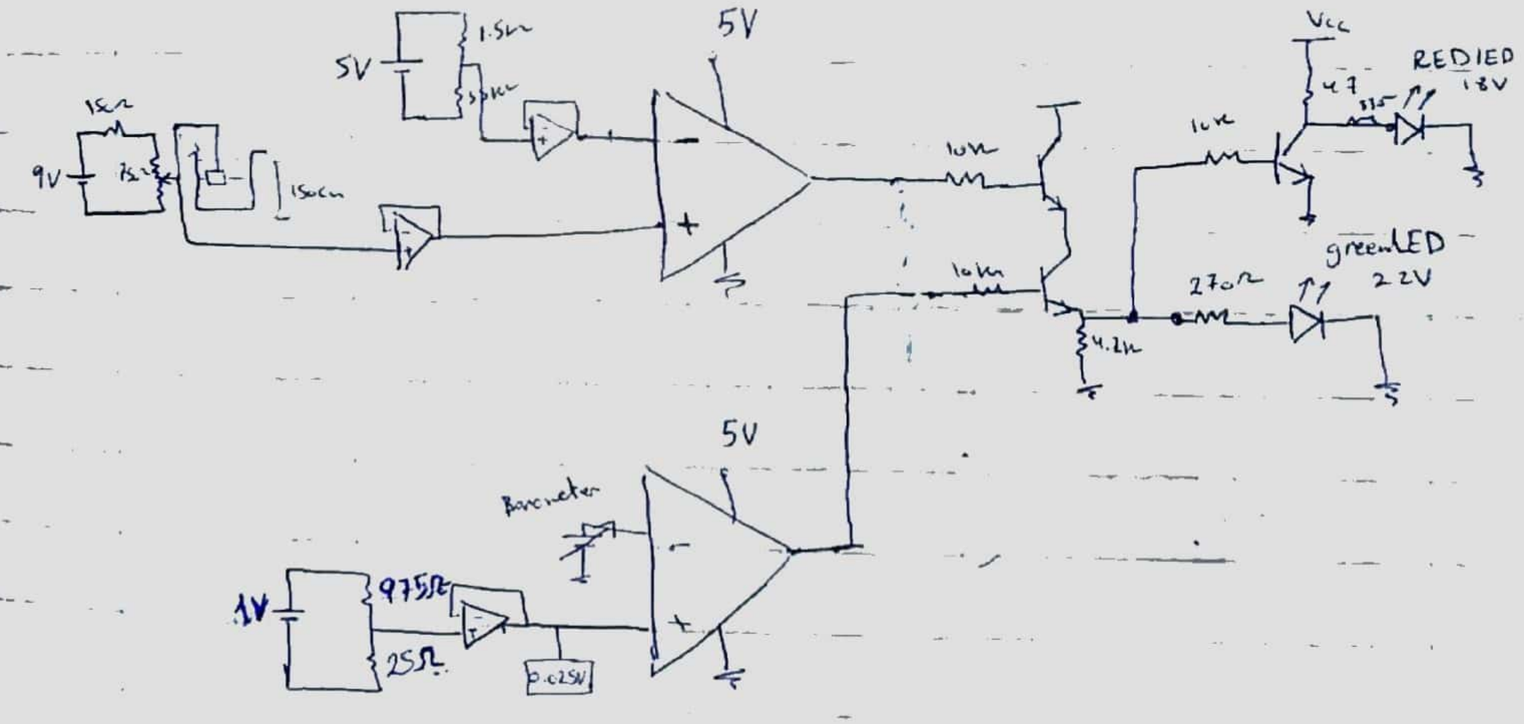
$$R = \frac{5\Omega}{cm} \times 70\,cm = 350\,\Omega$$

at 150 cm $\rightarrow$ $R_{tot} = \frac{5\Omega}{cm} \times 150\,cm = 750\,\Omega$

$$V = 9 \times \frac{350}{750+150} = \boxed{3.5V}$$

at 5 bar

$V = 25mV$



Q5 $V_M = 19\,mV$, $0°C$ refrence

	T	V
L	460	18.94 mV
M	T_M	19 mV
H	465	19.15 mV

$$T_M = T_L + \frac{T_H - T_L}{V_H - V_L}(V_M - V_L)$$

$$= 460 + \frac{465 - 460}{19.15 - 18.94}(19 - 18.94)$$

$$\boxed{T_M = 461.428571 4°C}$$

b) $V_{k10}(-40°C) = V_{k0}(-40°) - V_{k0}(10°C)$

$$= -1.5 - 0.4$$

$$\boxed{V_{k10}(-40°C) = -1.9\,mV}$$

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Electrical & Electronic Engineering Department

LPF

EE463 Final Exam- Time: 2 hr Spring 2019 25/9/2019

Q1) a-What is the meaning of single ended signal, differential signaland give example.

b- What is sample and what is hold and when we use them. [6 pts]

0.39

Q2) Using Temperature sensor (RTD-PT100),in the range (30C to 90C) and using Wheatstone bridge (Vs=9V, R1=110, R2=120),and using voltage to frequency converter VFC (scale factor= 10KHz/1.12V) .

a- Calculate the sensor output range, Wheatstone bridge output range and VFC output range.

b- Using a counter to convert to digital with sampling rate 180 sample/Sec,What is the output range of the counter, what is the value of the output of the counter if the temperature is ~~130~~C . 55C°

c- Draw Block diagram of the circuit. [16 pts]

Q3) An accelerometer sensor sensitivity is 0.145mA/ g , used for measuring pressure in the range (± 20 g). and the value of its output @ 0 g is 5.2mA, using 190 Ω converting to volt resistance ,Design signal condition circuits for bipolar (8 bit) ADC with voltage reference ±4V.

a) Calculate sensor output range (current,voltage,Binary). $= \frac{\text{input} + V_{ref}}{\Delta V}$

b) What is the digital output of ADC at the acceleration is 8 g.

c) What is the value of acceleration when the digital output is 0DH,92H. [15 pts]

d) If the frequency of the signal is 120Hz and there is unwanted noise with frequency 15KHz, design filter that attenuate the noise to 18% of its value, calculate the effect on the sensor output range. [05 pts]

Q4) Using RTD with the following table using Quadratic approximation of resistance versus temperature find the value of the RTD at 12.4°C.

Temperature (°C)	0	5	10	15	20
Resistance (Ω)	103.6	105.1	106.3	107.1	108.3
190	103.6	105.1	106.3	107.1	108.3

[08 pts]

Good Luck (Zeyad)

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spring 2019

Q2) PT100 (30°C ~ 90°C) $V_s = 9$, $R_1 = 110\Omega$, $R_2 = 120\Omega$

VFC 10 kHz / 1.12V

a) sensor output range ($111.7\Omega \sim 135.1\Omega$)

for bridge $R_2 R_3 = R_1 R_4 \rightarrow R_3 = \frac{R_1 R_4}{R_2}$

$R_4 = 111.7\Omega \rightarrow R_3 = 102.3916667\Omega$

at 30°C $V_A = 9 \times \frac{111.7}{111.7+120} = 4.3388002V$

$V_B = 9 \times \frac{102.3916667}{102.3916667+110} = 4.3388002V$

$V_0 = V_A - V_B = 0$

at 90°C $V_A = 9 \times \frac{135.1}{135.1+120} = 4.766366V$

$V_B = 4.338802 \rightarrow V_0 = V_A - V_B \Rightarrow V_0 = 0.427564V$

bridge output range ($0V \sim 0.427564V$)

VFC 10kHz 1.12V $\rightarrow$ = $\boxed{8.928571 kHz/V}$

x 1V

VFC output range (0 ~ 3.817536 KHz)

$\frac{180 \text{ sample}}{\text{sec}}$ → T = 0.005556 sec

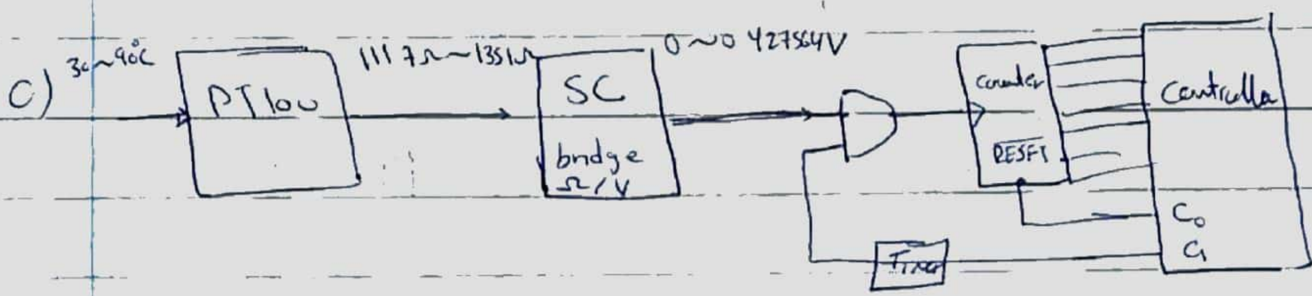
Counter output range (0 ~ 21.21023)

(0 ~ 21)

(00000 ~ 10101)

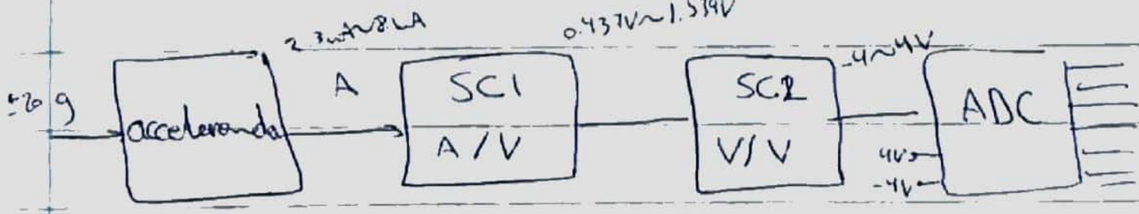
@ 55°C → 01001

c)



Q3) 0.145mA/g ±20g @0g = 5.2mA , R = 180 Ω

ADC ±4V



sensor output range (2.3mA ~ 8.1mA)

SC1 voltage range (0.437V ~ 1.539V)

4 = 1.539 M + offset

-4 = 0.437 M + offset

$V_{o2} = 7.259528 V_{o1} - 7.172414$

M 7.259528 , offset = -7.172414

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Binary range (00000000 ~ 11111111)

b @ 8g $V_{o_2} = 1.5999996\,V$

$\Delta V = \frac{8}{2^8} = 0.03125$

~~Digital output = 51 = 00110011~~

Digital output = 179 = 10110011

c 0D → 13 → $V_{o_2} = -3.59375$, $-17.968749\,g$

92 → 146 → V_{o_2} = → ~~13.125g~~ 2.8125g

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Q4) $R(T) = R(T_0)(1 + \alpha_1 \Delta T + \alpha_2 (\Delta T)^2)$

$T_1 = 0°C \longrightarrow R(0) = 103.6\,\Omega$

$T_0 = 10°C \longrightarrow R(10) = 106.3\,\Omega$

$T_2 = 20°C \longrightarrow R(20) = 108.3\,\Omega$

$R(0°) = R(10)(1 + \alpha_1(0-10) + \alpha_2(0-10)^2)$

$103.6 = 106.3(1 - 10\alpha_1 + 100\alpha_2)$

$10\alpha_1 - 100\alpha_2 - 0.0253998 = 0 \longrightarrow (1)$

$R(20) = R(10)(1 + \alpha_1(20-10) + \alpha_2(20-10)^2)$

$108.3 = 106.3(1 + 10\alpha_1 + 100\alpha_2)$

$10\alpha_1 + 100\alpha_2 - 0.0188147 = 0 \longrightarrow (2)$

$\alpha_1 = 2.210725\times10^{-3}$, $\alpha_2 = -3.29255\times10^{-5}$

$R(12.4) = R(10)(1 + \alpha_1(12.4-10) + \alpha_2(12.4-10)^2)$

$R(12.4) = 106.3(1 + (2.210725\times10^{-3}\times2.4) - (3.29255\times10^{-5}\times5.76))$

$\boxed{R(12.4) = 106.8438403\,\Omega}$

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Q1) Using Temperature sensor PT200 with (sensitivity =0.39/C°),in the range (-15C° to 180C°) in voltage divider which Vs=12V, R1= 180Ω , and use voltage to frequency converter VFC (scale factor= 5KHz/1.2V) and counter to convert the signal to digital form (Sampling rate : 20 sample/Sec)

a- Draw Block diagram of the circuit.
b- Calculate the sensor output range, voltage divider ,VFC ,counter output range.
c- What is counter output if the temperature is 112C .
d- What is the temperature if digital output is $(1111101000)_2$.

Q2) An accelerometer sensor sensitivity is 0.1mA/ g , used for measuring pressure in the range (± 20 g). and the value of its output @ 0 g = 1.2mA, using 140 Ω converting to volt resistance ,send signal long distance and design signal condition circuits for bipolar (8 bit) ADC with voltage reference ±3V.

a) Draw block diagram ,and circuit diagram.

b) Calculate sensor output range ,(I/V) range ?

d)What is the digital output of ADC at the acceleration is 11 g.

c) What is the value of acceleration when the digital output is $(100000)_2$.

3) Using the accelerometer MS1010 which its sensitivity= 270 mv/g, range ±10g, and sampling rate is 5 sample/ sec. Complete the following table.

Time(mS)	Acc. Output (mv)	Acc. (g)	Acc.(m/s^2)	Velocity(m/s)	Displacement(m)
0	0	0	0	0	0
200	420				
400	970				
600	1500				

$$v(t)_{m/s} = v[t-1] + \left(A(t) + A(t-1)\right)\frac{T}{2}$$

$$pos[t]_{m} = p[t-1] + \left(v(t) + v(t-1)\right)\frac{T}{2}$$

Good Luck (Eng. Zeyad Shennib)

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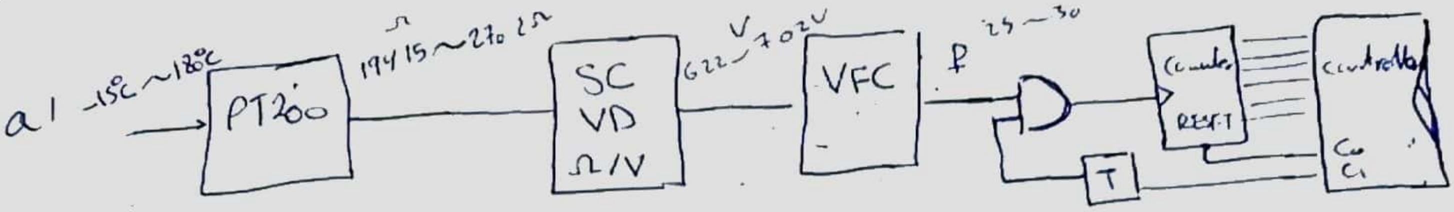
~~Ecat~~ Fall 2019 Midterm

Q1) PT 200, 0.39 Ω/°C (−15°C ~ 180°C) VD $V_s = 12V$

$R_1 = 180\ \Omega$ VFC 5KHz / 1.2V, sampling rate 20 sample/sec

a)



b) sensor range (−15°C ~ 180°C)

sensor output range $\left(\left(-15°C \times 0.39\frac{\Omega}{°C}\right) + 200\Omega \sim \left(180°C \times 0.39\frac{\Omega}{°C}\right) + 200\ \Omega\right)$

(194.15 Ω ~ 270.2 Ω)

voltage divider output range $\left(12 \times \frac{194.15}{194.15+180} \sim 12 \times \frac{270.2}{270.2+180}\right)$

= (6.226914V ~ 7.202132V)

VFC 5KHz → 1.2V → 4.166667 KHz/Volt

x → 1V

VFC output range = (25.945477 KHz ~ 30.008885 KHz)

sampling time = 0.05 sec

counter output range = (1297 ~ 1500)

= (10100010001 ~ 10111011100)

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c) @ $112^{\circ}C$ → sensor output RTD = $112 \times 0.391 + 200$

$= 243.68\,\Omega$

$V_{B} = 12 \times \dfrac{243.68}{243.68+180} = 6.901813V$

$f = 28.757556\,kHz$.

counter output = 1437

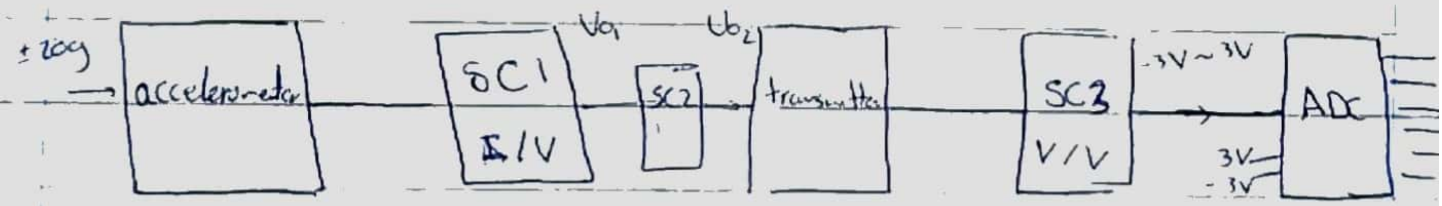
= 1011 0011 101.

d) $(1000)_{10}$ counter output = 1000 out of range

$f = \dfrac{1000}{0.05} = 20kHz$

Q2 $S = 0.1mA/g$, $\pm 20g$ @ $0g = 1.2mA$, $R = 140\,\Omega$

long distance ADC 8-bit $\pm 3V$

a) 

sensor output range $(-20g \times 0.1) + 1.2 \sim (20 \times 0.1) + 1.2)$

$= (-0.8mA \sim 3.2mA)$

SC1 I/V output range = $(-0.8 \times 0.14 \sim 3.2 \times 0.14)$

$= (-0.112V \sim 0.448V)$

SC2 → $V_{o2} = V_{o1} + 2$ → range $(1.888V \sim 2.448V)$

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for SC3

3 : 2.448 M + offset

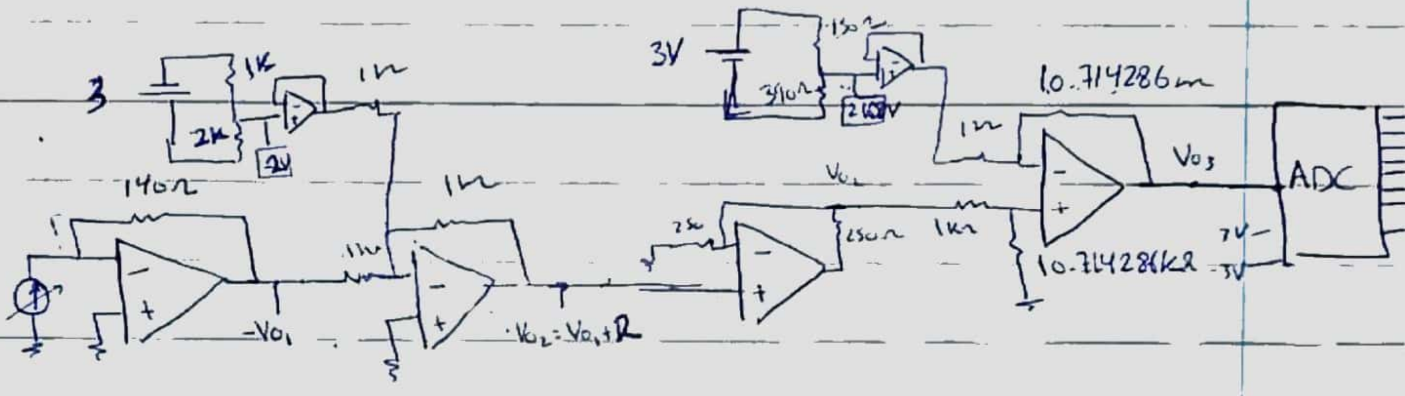
-3 = 1.888 M + offset

M = 10.714286 , offset = -23.228572

$V_{o3} = 10.714286\, V_{o2} - 23.228572$

$V_{o3} = 10.714286\,(V_{o2} - 2.168)$

a)



c) 11g → I = 2.3mA $\Delta V = \frac{6}{2^8} = 0.0234375$

$V_{o1} = 0.322V$

$V_{o2} = 2.322V$

$V_{o3} = 1.65V$

Digital output = $\frac{1.65+3}{0.0234375}$ = 198

= 11000110

d) 0010 0000 $\rightarrow$ 32

$V_{o3} = -2.25V$

$V_{o2} = 1.958V$

$V_{o1} = -0.042V$

$I = -0.3mA$

acceleration = $-15g$.

Q3)

T	acc (mV)	acc (g)	acc (m/s^2)	Velocity (m/s)	Displacement (m)
0	0	0	0	0	0
200	420	1.555556	15.260004	1.5260004	0.15260004
400	970	3.592593	35.243337	6.5763345	0.962834
600	1500	5.555556	54.500004	15.5506686	3.175534

$$V(t) = V(t-1) + \frac{T}{2}\left[A(t) + A(t-1)\right]$$

$$pos(t) = pos(t-1) + \frac{T}{2}\left[V(t) + V(t-1)\right]$$

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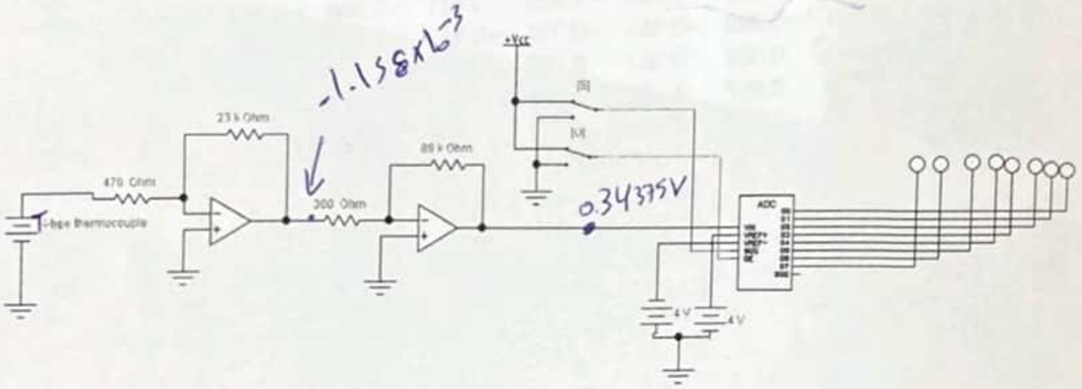
University of Tripoli – Faculty of Engineering

Electrical & Electronic Engineering Department

EE463 Final Exam Time: 2 hrs Fall 2019 6th September 2020

Q1) In climatic test room using T-type thermocouple sensor and using the following signal conditioning circuit, Calculate: a- The digital output if the temperature is 25F.

b- What is the temperature (°C) if the digital output is (10001011). [18 pts]



Q2) Using RTD type (PT200) in the temperature range (-20°C to 120°C), as a resistance R4 in Wheatstone bridge, R1=190Ω, R2=215Ω, Vs=12V.

a- Calculate sensor output range, calculate R3 for balancing the bridge?, calculate the bridge output voltage range ? 169.85

b- Using VFC (5.4Khz/2.5V) for A/D conversion, calculate VFC output range?

c- What is the counter output range with sampling rate 12sample/sec? and what is counter output if temperature is -5°C ? 16.164

d- Draw Block diagram of the circuit. [18 pts]

Q3) An accelerometer, with sensitivity is 0.95mA/ g , used for measuring acceleration in the range (± 15 g) and the value of its output @ 0 g is 3.6mA, using 150 Ω converting to volt resistance ,Design signal condition circuits for bipolar (8 bit) ADC with voltage reference ±5V.

a) Calculate sensor output range (current, voltage). 136

b) What is the digital output of ADC at the acceleration is 1 g ? 1.87

c) What is the value of acceleration when the digital output is 09H, 90H? [16 pts]

-13.94

Q4) Using RTD with the following table using Quadratic approximation of resistance versus temperature find the value of the RTD at 7C.Is the sensor PTC or NTC and why?

Temperature (°C)	0	4	8	12	16
Resistance (Ω)	102.6	104.1	105.3	106.1	107.3
	T_1		T_0		T_2

[08 pts]

Good Luck (Zeyad)

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Final Exam   Fall 2019

Q1)

$25F = \frac{5}{9}(25-32) = -3.888889°C$

	T	V
L	-5	-0.191
M	-3.888889	V_M
H	-0	-0

$V_M = V_L + \frac{V_H - V_L}{T_H - T_L}(T_M - T_L)$

$V_M = -0.191 + \frac{-0-(-0.191)}{-0-(-5)}(-3.888889-(-5))$

$V_M = -0.148556 mV$

after inverting amp $V_2 = -\frac{23k\Omega}{470\Omega} \times -0.148556$

$V_2 = 7.269762 mV$

$V_3 = \frac{-89k\Omega}{300\Omega} \times 7.269762$

$V_3 = -2.156696 V$

for the ADC $\Delta V = \frac{4-(-4)}{2^8} = 0.03125 V$

Digital output $= \frac{-2.156696+4}{0.03125} = \boxed{59 = 00111011}$

b) 10001011 → 139 $139 = \frac{V_3+4}{0.03125}$ → $V_3 = 0.34375V$

$V_3 = \frac{-89k\Omega}{300\Omega} V_2$ → $V_2 = -1.158708 mV$

$V_2 = \frac{-23k\Omega}{470\Omega} V_1$ → $V_1 = 0.0236 7794 mV$

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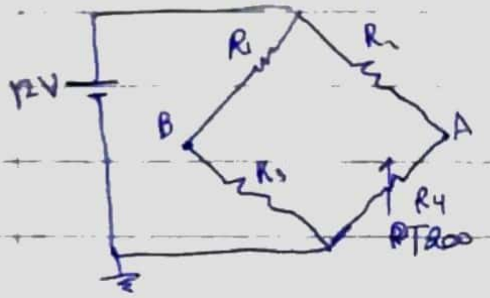
	T	V
L	0	0
M	T_M	0.02367794
H	5	0.193

$$T_M = T_L + \frac{T_H - T_L}{V_H - V_L}(V_M - V_L)$$

$$T_M = 0 + \frac{5-0}{0.193-0}(0.02367794 - 0)$$

$$\boxed{T_M = 0.613418^\circ C \qquad T = 33.10415 F}$$

Q2



For PT200 $(-20^\circ C \sim 120^\circ C)$

sensor output range $= (-20^\circ C \times 0.39\frac{\Omega}{^\circ C} + 200 \sim 120 \times 0.39 + 200)$

$= (192.2\,\Omega \sim 246.8\,\Omega)$

for balance $\frac{R_1}{R_3} = \frac{R_2}{R_4}$, $R_3 = \frac{R_1 R_4}{R_2}$

$$R_3 = \frac{190 \times 192.2}{215} = 169.8511628\,\Omega$$

voltage output range: @ $-20^\circ C$

$$V_A = 12 \times \frac{192.2}{192.2 + 215} = 5.664047V$$

$$V_B = 12 \times \frac{169.8511628}{169.85} = 5.664047V$$

$V_A = V_B \rightarrow \Delta V = 0V$, @ $120^\circ C$

$$V_A = 12 \times \frac{246.8}{246.8 + 215} = 6.413166V, \; V_B = 5.664047$$

$\Delta V = V_A - V_B = 0.749118V$

voltage output range $= (0 \sim 0.749118V)$

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b) $\frac{5.4\,KHz}{25\,V} = 216\,KHz/V$

VFC output range = (0 ~ 1618.095 KHz)

c) $T = \frac{1}{12} = 0.0833333$

counter output range = (0 ~ 134) = (00000000 ~ 10000110)

if $T = -5°C \rightarrow R_4 = t5 \times 0.39 + 200 = 198.05\,\Omega$

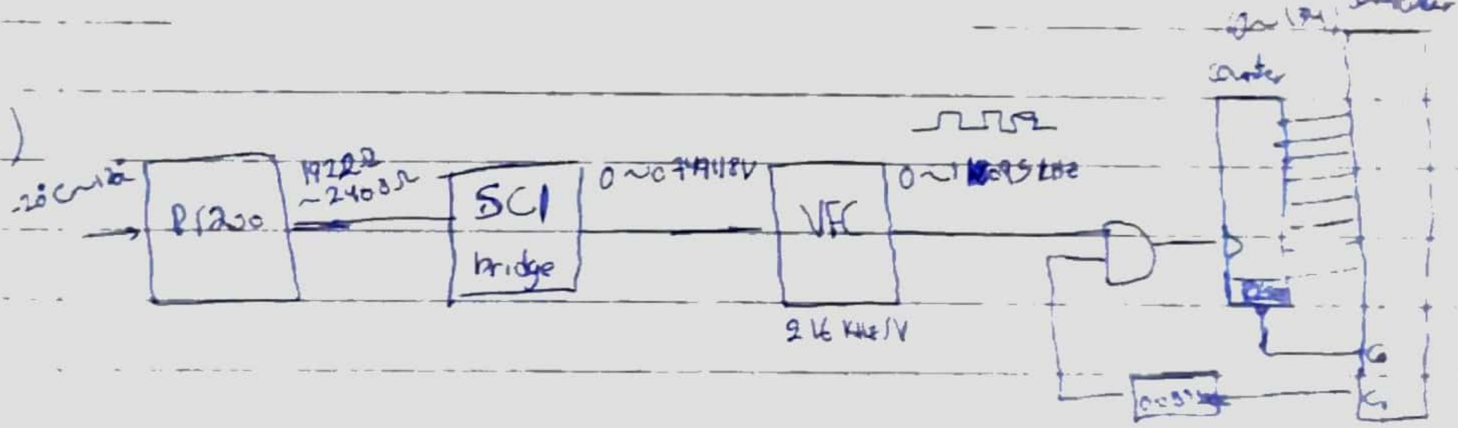
$V_A = 12 \times \frac{198.05}{198.05+215} = 5.753783\,V$, $V_B = 5.664047$

$V_o = 0.089736$

$f = 0.19382976\,KHz$

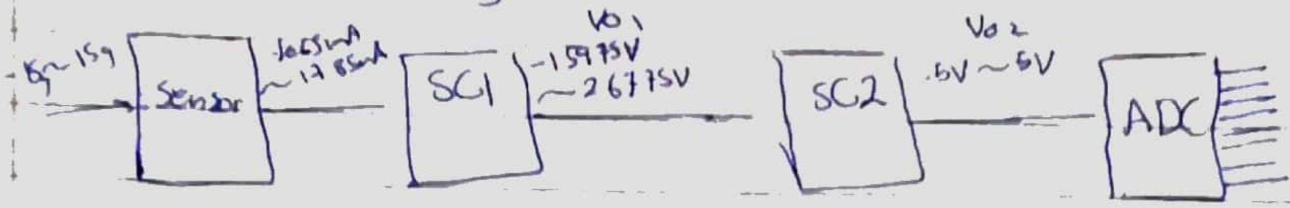
counter output = 16 = (00010000)

d)



Q3. Accelerometer current output range = ((-15x0.95)+3.6 ~ (15x0.95)+3.6)
= (-10.65mA ~ 17.85mA)

voltage output range = (-1.5975V ~ 2.6775V)



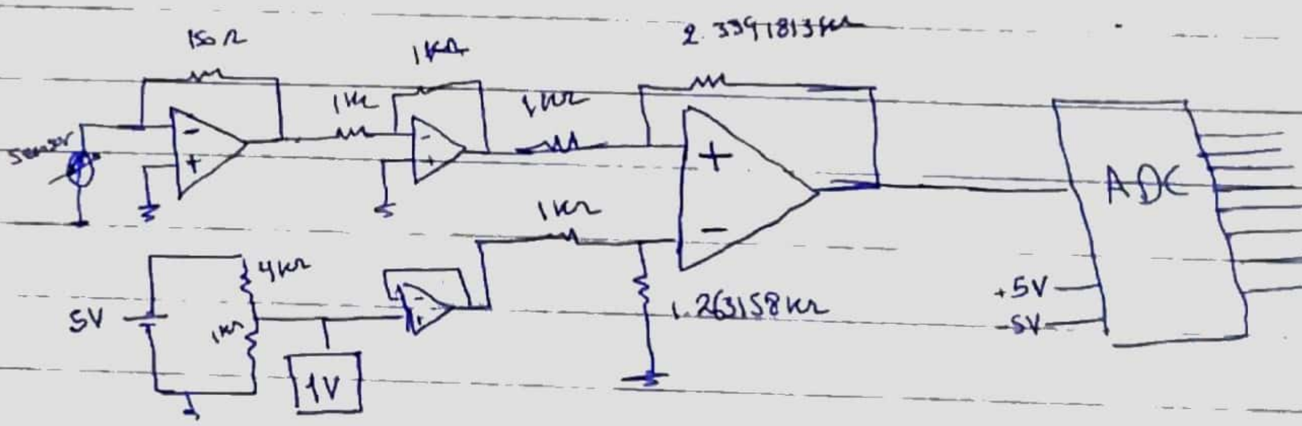
SC2

$$5 = 2.6775M + offset$$
$$-5 = -1.5975M + offset$$
$$M = 2.3391813, \quad offset = -1.263158$$

$$V_o = 2.3391813 V_{in} - 1.263158$$

V_{in}	-1.5975	0.54	2.6775
V_{ou}	-5.000001	-9.8×10^{-8}	4.99999993

جدول التحقيق



b) @ 1g $\rightarrow$ $I = 4.55mA$

$V_{o_1} = 0.6825V$

$V_{o_2} = 0.3333332V$

For the ADC $\Delta V = \frac{5-(-5)}{2^8} = 0.0390625V$

Digital output $= \frac{0.3333332 + 5}{0.0390625} = 136 = 1000\,1000$

c) $09H \rightarrow 1001$

$= 9$

$9 = \frac{V_{o2}+5}{\Delta V} \rightarrow \cancel{V_{o_2}} =$

$V_{o_2} = -4.6484375V$

$V_{o_2} = 2.3391813 V_{o_1} - 1.263158$

$V_{o_1} = -1.447207V$

$I = \frac{V_{o_1}}{R} = -9.6480467mA$

$I = (a \times 0.95) + 3.6$

$\boxed{a = -13.945312g}$

$90H \rightarrow 1001\,0000$

$= 144$

$144 = \frac{V_{o2}+5}{\Delta V}$

$V_{o_2} = 0.625V$

$V_{o_1} = 0.8071875V$

$I = 5.3812503mA$

$\boxed{a = 1.875g}$

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$R(T) = R(T_0)(1 + \alpha_1 \Delta T + \alpha_2 (\Delta T)^2)$

$T_1 = 0°C \rightarrow R(0) = 102.6\,\Omega$

$T_0 = 8°C \rightarrow R(8) = 105.3\,\Omega$

$T_2 = 16°C \rightarrow R(16) = 107.3\,\Omega$

$R(0) = R(8)(1 + \alpha_1(0-8) + \alpha_2(0-8)^2)$

$102.6 = 105.3(1 - 8\alpha_1 + 64\alpha_2)$

$8\alpha_1 - 64\alpha_2 - 0.02564103 = 0 \longrightarrow (1)$

$R(16) = R(8)(1 + \alpha_1(16-8) + \alpha_2(16-8)^2)$

$107.3 = 105.3(1 + 8\alpha_1 + 64\alpha_2)$

$8\alpha_1 + 64\alpha_2 - 0.01899335 = 0 \longrightarrow (2)$

$\alpha_1 = 2.78964875 \times 10^{-3}$, $\alpha_2 = -5.1935 \times 10^{-5}$

$R(7) = R(8)(1 + \alpha_1(7-8) + \alpha_2(7-8)^2)$

$R(7) = 105.3(1 - (2.78964875 \times 10^{-3}) - (5.1935 \times 10^{-5}))$

$\boxed{R(7) = 105.0007812\,\Omega}$

PTC (positive temperature coefficient, sensor output goes up as the temperature goes up.

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University of Tripoli - Faculty of Engineering

Electrical & Electronic Engineering Department

EE463 Mid term exam Time: 1: 30 hr Fall 2020 29/04/2020

Q1) Pressure sensor sensitivity(0.14mA/bar),@0bar=37mA.used in the range (0~50bar). use R=120Ω for conversion to volt:

a-Design signal conditioning circuit using 8bit ADC with voltage reference(0~4V).

b-Draw block diagram of the circuit.

c-Calculate sensor, I/V circuit output range?

D-What is the digital output if pressure is 14bar?

e- Calculate the value of pressure if digital output is $(11010100)_2$. (14 marks)

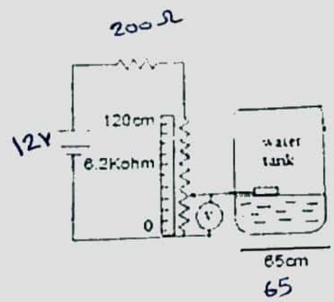
Q2) using the following circuit to measure liquid level in a cylindrical tank, and using VFC with scale factor 6.2KHz/2.25V,with rate of 15sample/sec .a-Draw the block diagram.

b-Calculate the output voltage range (Vo),VFC output range, counter output range.

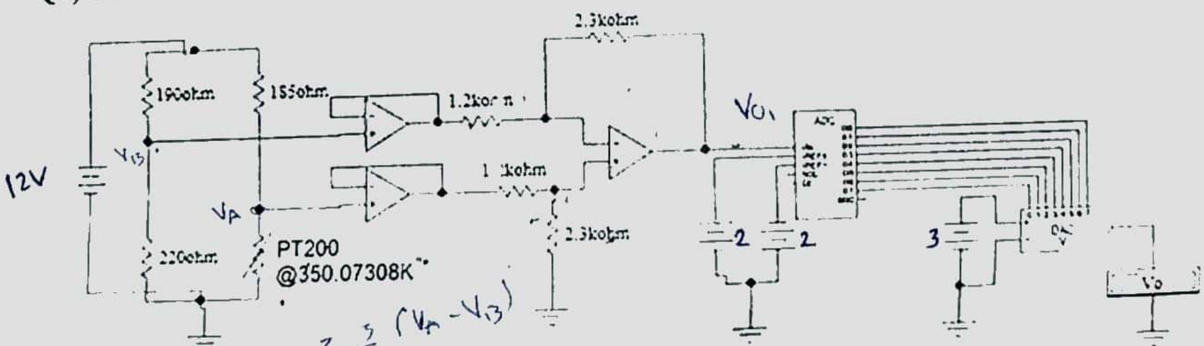
c- how many bits we need for the counter and controller digital inputs.

d-what is the counter output will be, if the liquid level is 47cm, and what is the volume of the liquid? (10 marks)

10 60 800



Q3) Calculate the value of Vo, if the temperature in Kelvin. (8 marks)



$Vo = \frac{2.3}{1.2}(V_A - V_B)$

Q4) Design circuit that operate heater if temperature is less than 32C(using PT100), and open release valve if pressure is more than 10 bar, operate yellow LED if one of them is work. (8 marks)

2.2V at least

$\boxed{S = 12mV/bar}$

Good luck

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Fall 2020 midterm

Q1) Sensor range (0 ~ 50 bar)

Sensor current output range ((0 x 0.14 + 37 ~ (50 x 0.14) + 37)

= (37 mA ~ 44 mA)

Sensor voltage output range = (37 mA x 120 Ω ~ 44 mA x (120 Ω))

= (4.44 V ~ 5.28 V)

SC

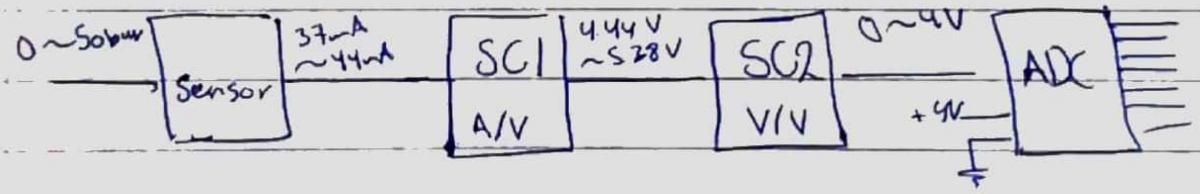
4 = 5.28 M + offset

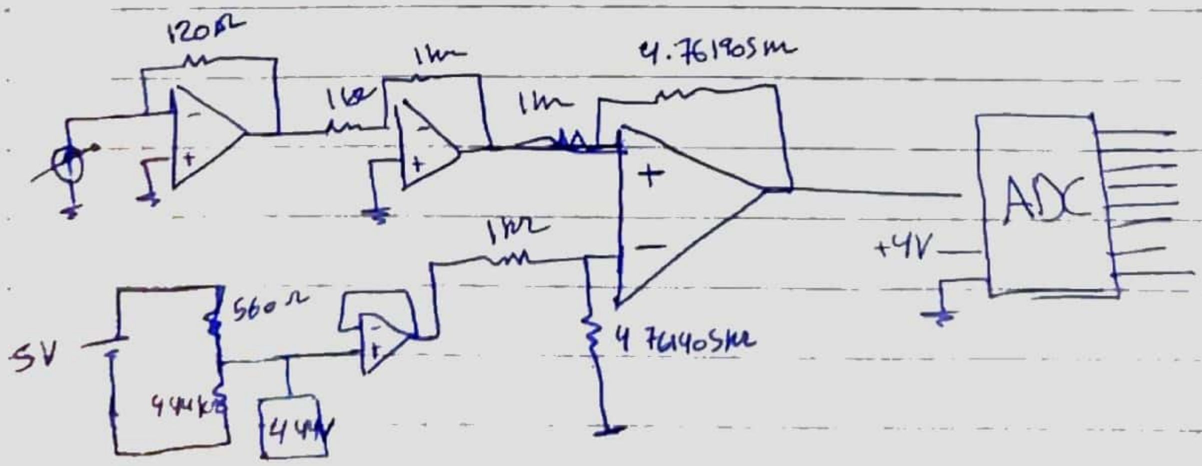
0 = 4.44 M + offset

M = 4.761905 , offset = -21.1428582

$V_{o_2} = 4.761905\, V_{o_1} - 21.1428582$ وبعد وصول التحقق

$V_{o_2} = 4.761905\, (V_{o_1} - 4.44)$





D) @ 14 bar $I = (14 \times 0.14) + 37 = 38.96\ mA$

$V_{o_1} = 4.6752V$, $V_{o_2} = 1.12V$

for ADC $\Delta V = \frac{4-0}{2^8} = 0.015625V$

Digital output $= \frac{1.12}{0.015625} = 71 = \boxed{01000111}$

e) $11010100 \rightarrow 212$ $V_{o_2} = 212 \times \Delta V = 3.3125V$

$V_{o_1} = 5.135625V \rightarrow I = 42.796875mA$

$a = 41.40625g$

Q2 tank height range (0cm ~ 120cm)

voltage range $(0V \sim 12 \times \frac{6.2}{6.2 + 0.2})$

$= (0V \sim 11.625V)$

VFC $\frac{6.2\ KHz}{2.25V} = 2.75555556 KHz/V$

VFC output range $= (0KHz \sim 32.0333333 KHz)$

$T = \frac{1}{15} = 0.0666667\ sec$

counter output range = $(0 \sim 2135)$
$= (000000000000 \sim 100001010111)$

c) 12 bits

d) at 47cm ~~120cm~~ 120cm ⟶ 11.625V

$S = 0.096875\ V/cm$

@ 47cm $V = 4.553125\ V$

$f = 12.546389\ kHz$

counter output = 836 = 001101000100

Q3) $V_B = \dfrac{12 \times 220}{220+190} = 6.439024V$

$V_A \Rightarrow R_3$ @ $176.7072667°C$
$R_3 = 268\ 915834$

$V_A = 7.10922547V$

V_{o1} (before ADC) $= \dfrac{23}{1.2}(V_A - V_B) = 1\ 2845\ 53V$

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for ADC $\Delta V = \frac{2-(-2)}{2^8} = 0.015625V$

Digital output $= \frac{1.284553+2}{0.015625} = 210 = 11010010$

Digital input for DAC $= 01001011 = 75$

$\Delta V = \frac{3}{2^8} = 0.01171875V$

$V_o = 75 \times \Delta V \rightarrow \boxed{V_o = 0.87890625V}$

(Q4) PT100 @ 32°C $R = (32 \times 0.39) + 100$

$R = 112.48\Omega$

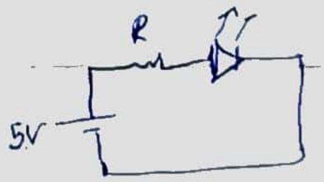
use voltage devider $R = 200\Omega$, $V = 5V$

$V = 5 \times \frac{112.48}{112.48+200} = 1.799795V$

for the pressure sensor

@ 10 bar $V = 0.12V$

yellow 2.2V



$R = \frac{5-2.2}{10mA} = 280\Omega$

use $R = 330$

$I = 8.4848mA$

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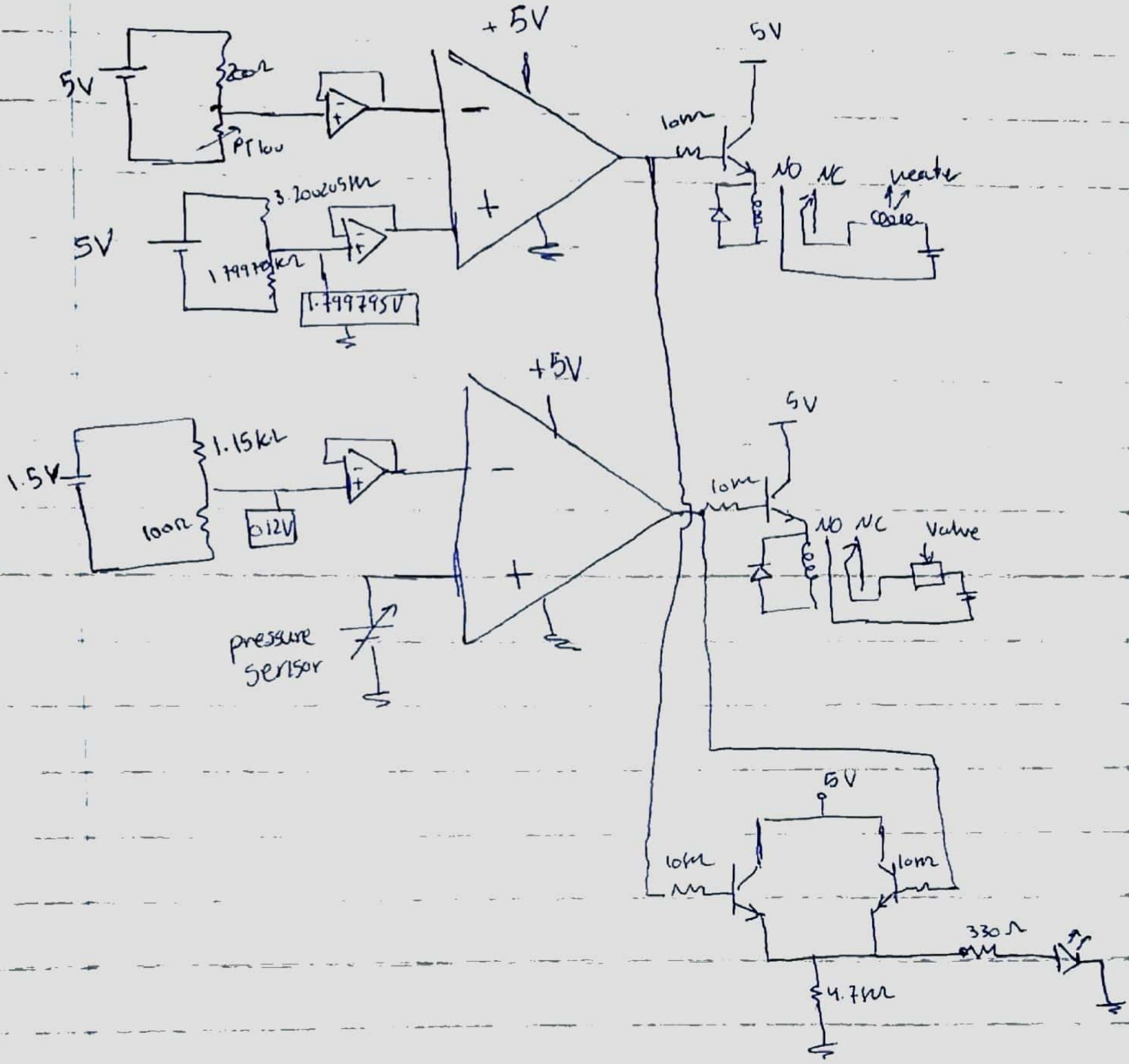

لو استفدت منه، أرجو منك

الدعوة بالرحمة لوالدي ^^

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